U.S. Army Research Institute
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Research Report 1708

Developing an Automated Training Analysis and Feedback System for Tank Platoons

Bill Brown, Stephen Wilkinson, John Nordyke, David Riede,
Steve Huyssoon, Don Aguilar, and Ray Wonsewitz
LB&M Associates, Inc.

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U.S. Army Research Institute

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Director

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14. ABSTRACT *(Maximum 200 words)*:

The Army has adopted the After Action Review (AAR) process as the means of providing feedback after collective training exercises, and the quality of AARs depends upon how well trainers can prepare and use data displays to show what happened during exercises and guide interactive discussions on how to improve unit performance. A previous report described a demonstration of the capability of the Automated Training Analysis and Feedback System (ATAFS) to automatically generate AAR aids after exercises in the networked simulator environment. This report describes the results of a follow-on effort to complete the development of the complete set of planned AAR capabilities and test the prototype ATAFS in a mix of Army National Guard training environments.

15. SUBJECT TERMS

After Action Review (AAR) Expert system Collective training feedback Unit take home package Simulation Networking (SIMNET) Virtual simulations

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FOREWORD

The After Action Review (AAR) is the U.S. Army's method for providing units with feedback after collective training exercises. The AAR is an interactive discussion intended to help units discover what happened, why it happened, and possible corrective actions. These discussions are facilitated by AAR aids (data displays) that illustrate critical exercise events.

Simulation Networking (SIMNET) provides the potential for cost-effective training, but realizing this potential requires presenting units with feedback quickly after an exercise so that they can return to their simulators and repeat a mission. Reaching this goal is a challenge, because exercise control functions compete with feedback preparation for the time of trainers during exercises, and software systems did little to help trainers select, create, and display AAR aids.

In late 1994, LB&M Associates demonstrated the concept of an Automated Training Analysis and Feedback System (ATAFS) in the context of a Phase II Small Business Innovation Research (SBIR) project. To help ensure trainers would have a bin of AAR aids at their disposal when an exercise ends, the ATAFS used an expert system to support the automated generation of AAR aids. The success of this effort led to the installation and testing of a more robust system in the context of a Phase III SBIR project funded by the Advanced Research Projects Agency Simulation in Training for Advanced Readiness program.

This report describes the implementation, testing, and refinement of an ATAFS made more robust by porting the capabilities to a more powerful workstation, increasing the collective tasks addressed by the expert system to include essentially all of the armor platoon tasks supported by SIMNET, and adding a user program of instruction including computer-based training. User feedback was gained by installing the ATAFS at six U.S. Army National Guard training sites and at the Close Combat Tactical Trainer CCTT development facility.

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DEVELOPING AN AUTOMATED TRAINING ANALYSIS AND FEEDBACK SYSTEM FOR TANK PLATOONS

EXECUTIVE SUMMARY

Research Requirement:

The U.S. Army has adopted the After Action Review (AAR) process as the primary means of providing feedback after collective training exercises. AAR quality is dependent upon how well the observer/controller (O/C) or trainer can use data displays to show what happened during the exercise and guide interactive discussions on how to improve performance. Trainers require help in preparing and presenting these data displays or AAR aids. In virtual simulations for platoon-size units, O/Cs generally present the AAR within 10 to 30 minutes after exercise termination. The need to provide a rapid turn around from exercise-to-AAR-to-exercise makes it difficult for most trainers to adequately prepare for the AAR without assistance. Meeting this need for assistance is complicated by the fact that trainers generally have little time available to attain proficiency on an AAR system. In a Phase II Small Business Innovation Research (SBIR) project we demonstrated the concept of an Automated Training Analysis and Feedback System (ATAFS) that employed an expert system to automate the production of candidate AAR aids for simulation networking (SIMNET) exercises. A need existed to develop a more complete ATAFS and test the system in applications to tank platoon training within a variety of Army National Guard (ARNG) training environments.

Procedure:

We ported the existing ATAFS capabilities from an AMIGA platform to a Silicon Graphics platform and continued the implementation of additional planned capabilities. These implementations were intended to provide users with the capabilities to employ additional types of AAR aids, edit the aids and load aids to VCR tape for use as an electronic Take Home Package (THP). The expert system was also expanded to address essentially all of the tank platoon collective tasks trainable in the SIMNET environment.

We installed six ATAFS workstations at ARNG training sites and one workstation at Lockheed Martin's Close Combat Tactical

Trainer (CCTT) facilities to support experimentation, testing, and evolutionary development of the CCTT AAR system. To facilitate on-site training, we developed a highly interactive, computer-based training package to provide O/Cs initial and sustainment training in the operation of ATAFS. This training package was intended to help ARNG trainers achieve proficiency in ATAFS operations at their home station armory prior to performing O/C duties during an actual exercise.

We defined the functional requirements and developed a graphical user interface for an ATAFS Authoring Tool (ATAFS-AT). The purpose of the authoring tool is to provide training analysts, who are not programmers, the capability to modify existing expert system rules or prepare new rule sets to automate AAR aid production. The ATAFS-AT software user's manual provides a methodology to analyze the AAR products required for a given exercise table or scenario and shows how the training analyst, using an intuitive user interface, could generate code that would produce the desired AAR aids.

Findings:

Trainers with widely varying AAR experience were able to master operation of ATAFS with very little training. Most O/Cs achieved proficiency in the operation of ATAFS after 2 hours of computer-based training and a 1.5-hour practical exercise. We observed instances in which O/Cs successfully prepared AARs with ATAFS after only a 30-minute demonstration of the system.

We added new capabilities, modified existing capabilities, and corrected software problems in response to feedback from users and researchers. Additional requirements for system modifications were identified and documented but funding and time constraints did not allow us to address these requirements.

Training analysts and researchers are keenly interested in the continued development of the ATAFS-AT, so the user can develop standardized AAR products for exercise tables or devise rule sets to extract data for research purposes without contractor or programmer involvement.

Utilization of Findings:

ATAFS demonstrated technology that the government can leverage to automate AARs for constructive and live simulations as well as existing and emerging virtual simulations. Combat developers of the Standard Army After Action Review System (STAARS) view ATAFS as a technology that has great potential to meet many of the STAARS requirements. There is strong interest in integrating ATAFS capabilities into the CCTT AAR system to automate AAR preparations. LB&M has provided the government ATAFS source code and documentation with unlimited rights to apply ATAFS technology to any military application.

DEVELOPING AN AUTOMATED TRAINING ANALYSIS AND FEEDBACK SYSTEM FOR TANK PLATOONS

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Introduction

The U.S. Army has adopted the After Action Review (AAR) process as the primary means of providing feedback after collective training exercises. The AAR is an interactive discussion with the goal of helping exercise participants identify unit strengths and weaknesses in enough detail to point the way towards possible corrective actions. AAR quality is dependent upon how well the observer/controller (O/C) or trainer can use data displays to show what happened during the exercise and guide interactive discussions on how to improve performance.

Efforts to apply automation in helping O/Cs to plan, prepare and conduct AARs must consider the ongoing effort to define a Standard Army After Action Review System (STAARS) under the Warfighter XXI program (Meliza, 1996). STAARS is intended to meet the needs of O/Cs having various degrees of experience conducting AARs in the live, virtual, and constructive training environments. At one end, STAARS is expected to provided relatively inexperienced O/Cs with a set of AAR aids at the end of an exercise. For O/Cs with more experience, STAARS is expected to provide menus of candidate AAR aids. Finally, STAARS is expected to provide highly experienced O/Cs with the capability to create their own AAR aids.

LB&M Associates, Inc., (LB&M) developed the Automated Training Analysis and Feedback System (ATAFS), an automated AAR system for Simulation Networking (SIMNET) exercises. LB&M developed the ATAFS as a U.S. Army Simulation, Training, and Instrumentation Command (STRICOM) Small Business Innovation Research (SBIR) Phase II project under the technical supervision of the U.S. Army Research Institute's (ARI), Simulator Systems Research Unit, (Brown, Wilkinson, Nordyke, Hawkins, Robideaux, and Huyssoon, 1996). After successful demonstration of a proof-of-principle prototype, the government awarded LB&M a follow-on Phase III SBIR contract to develop a more robust ATAFS prototype to support the Defense Advanced Research Projects Agency's (DARPA), Simulation in Training for Advanced Readiness (SIMITAR) program. During the project ARI continued to provide technical oversight of ATAFS development.

The principal objectives of the project were (a) to test and refine ATAFS and a user program of instruction (POI) in a variety of training environments during training conducted by U.S. Army National Guard (ARNG) tank platoons, and (b) to provide an ATAFS for testing and experimentation to support the development of an

AAR workstation for the U.S. Army's next generation of networked simulators, the Close Combat Tactical Trainer (CCTT). This report provides the results of LB&M's efforts and documents project methodology, findings, and conclusions.

ATAFS is a prototype system. However, ATAFS has demonstrated technology that the government can leverage to automate AARs for constructive and live simulations as well as existing and emerging virtual simulations. LB&M has provided the government ATAFS source code and documentation with unlimited rights to apply ATAFS technology to any military application. There is also strong interest in integrating ATAFS capabilities into the CCTT AAR system to automate AAR preparations.

During the project, we accomplished the five tasks listed below to transition ATAFS from a proof-of-principle prototype to a more robust prototype that (a) O/Cs could use to prepare AARs for ARNG tank platoons to test and refine the system and its user POI, and (b) researchers and material developers could use in experimentation and testing to develop an objective AAR system.

(1) LB&M software developers ported the ATAFS from its proof-of-principle Amiga platform, developed under the Phase II contract, to a Silicon Graphics, Inc. (SGI) computer.

(2) Our training developers conducted a task/learning analysis of ATAFS user tasks (LB&M, 1995a) and developed a computer-based training (CBT) program POI and an ATAFS User's Manual (LB&M, 1996a). We installed the system and conducted user training at six ARNG training sites and the CCTT development facility.

(3) We expanded the capability of ATAFS' expert system to automate AAR aids for additional tank platoon tasks (LB&M, 1996b).

(4) We increased ATAFS' functionality and improved the user interface based on comments received from subject matter experts (SMEs) and users during installation and demonstrations of the system.

(5) We defined functional requirements, prepared a software user's manual, and developed a graphical user interface for an ATAFS Authoring Tool (ATAFS-AT) that will permit non-programmers to develop rule sets to automate AAR aid production (LB&M, 1996c).

Background

The After Action Review (AAR) Process

The AAR is intended to help a unit decide what happend during an exercise, decide why it happened, and identify potential corrective actions. The O/C serves as the facilitator during AAR presentations and employs the Socratic method to stimulate player discussions and self-discovery through the use of open-ended and leading questions that do not evoke a "yes" or "no" answer, such as: "What happened when you ordered the action drill?" During the AAR the players assess their own performance and identify those tasks accomplished to standard and those tasks requiring improvement (Scott, 1983; Department of the Army, 1993). See Figure 1.

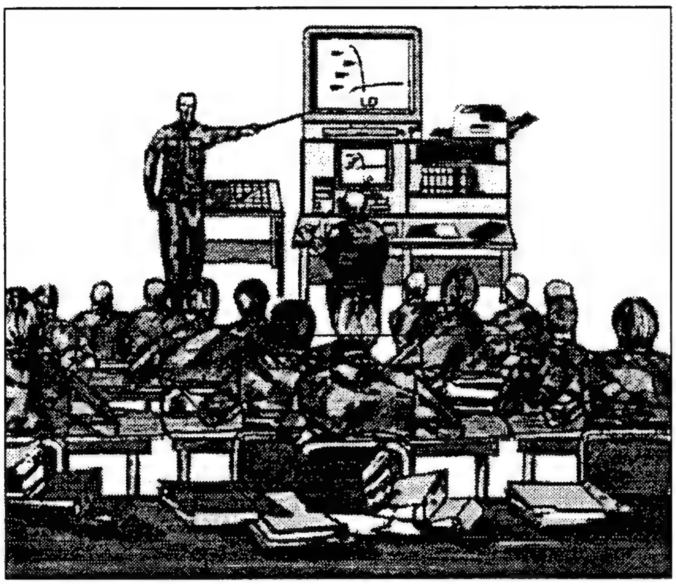


Figure 1. AAR presentation.

The O/C guides player discussions to establish the causes and effects that led to the outcome of the battle through the use of various displays or AAR aids. These AAR aids portray unchallengeable "ground truths" of critical tactical events, employing computer-generated imagery depicting various views of the battle. AAR aids may also be in the form of statistical tables and graphs that provide performance measurements for a critical tactical event or phase of the battle. The AAR aids display the unit's plan, identify "what happened," and stimulate player discussions on "why it happened". During these discussions players learn from their mistakes and benefit from the lessons learned by other players. The AAR in effect becomes the bridge between the completed training event and the next

training event, providing post-exercise learning on "how to improve" that will enable leaders to fix training weaknesses.

Need for Helping Trainers to Conduct AARs

In current and emerging virtual simulations, tools to support O/Cs in the preparation of AARs are labor intensive (Meliza, Bessemer, and Tan, 1994). The quality of the AAR is highly dependent upon (a) the O/C's technical and tactical competence, (b) ability to operate the AAR system and concurrently perform control duties, and (c) the time available to complete AAR preparations. O/Cs receive little assistance from their AAR systems before, during, or after a simulation exercise and are overwhelmed by exercise control duties and AAR preparations. As a result exercise participants do not receive immediate, comprehensive training feedback that they can put to use prior to the next training event, unless a highly experienced, dedicated O/C team prepares the AAR. Given the reductions in military funding, it is unlikely that every simulation facility will have a dedicated O/C team to prepare and conduct AARs (Meliza, 1996). What is needed is an AAR system to support the inexperienced O/C in the preparation of a timely, meaningful AAR presentation that approaches the quality of the AAR prepared by the seasoned O/C.

Overview of ATAFS Capabilities

ATAFS assists the O/C in monitoring and assessing player performance during tank platoon SIMNET exercises and automates much of the AAR preparations. During the exercise ATAFS employs an expert/rule-based system to automate the production of candidate AAR aids. The O/C may review these candidate AAR aids as they are prepared during the exercise or review all aids immediately after exercise termination. From the total set of candidate AAR aids generated during an exercise, the O/C may select and/or modify the aids for the AAR presentation and the unit's Take Home Package (THP).

ATAFS provides the O/C the capability to observe the exercise in near-real time as the system produces candidate AAR aids in the background. We use the term near-real time, because the display of events is a few seconds or more after the occurrence of the events due to the time required to process data. ATAFS also provides the O/C the capability to examine past events in exercise history, prepare custom/manual AAR aids, then return to a near-real time view of the exercise.

ATAFS produces several types of AAR aids that will help the O/C generate player discussions during the AAR. ATAFS produces top-down views of player activity that may be presented as still or animated views of the battle. ATAFS also allows the O/C to

play back the audio from a tactical communications net synchronously with animated top-down views of the battle. ATAFS produces statistical tables and graphs that may be used to make key teaching points addressing a tactical event or phase of the battle. The ATAFS software user's manual contains detailed discussions and illustrations on how to operate the AAR system (LB&M, 1996a).

ATAFS Workstation

The ATAFS work station is configured as depicted in Figure 2. The O/C interfaces with ATAFS principally through the mouse. The O/C uses the keyboard to input player unit administrative data and enter or modify text in pre-formatted AAR aids. The O/C uses the digitizing tablet to trace tactical operations overlays into the system prior to the exercise. ATAFS eavesdrops on SIMNET's Ethernet and captures, stores and displays the player unit's activity in the form of computer-generated graphics on ATAFS' workstation monitor. The O/C may observe player activity in near-real time or in exercise history. After the exercise, the O/C uses the ATAFS workstation to conduct the AAR. The large 35 inch television is the medium for the AAR presentation. After the AAR, the O/C may download AAR aids to a VCR tape to serve as a unit THP. The O/C may also print static AAR aids on the printer and provide the aids to the players to further emphasize some of the key teaching points. ATAFS' tape drive permits O/Cs to archive completed exercises.

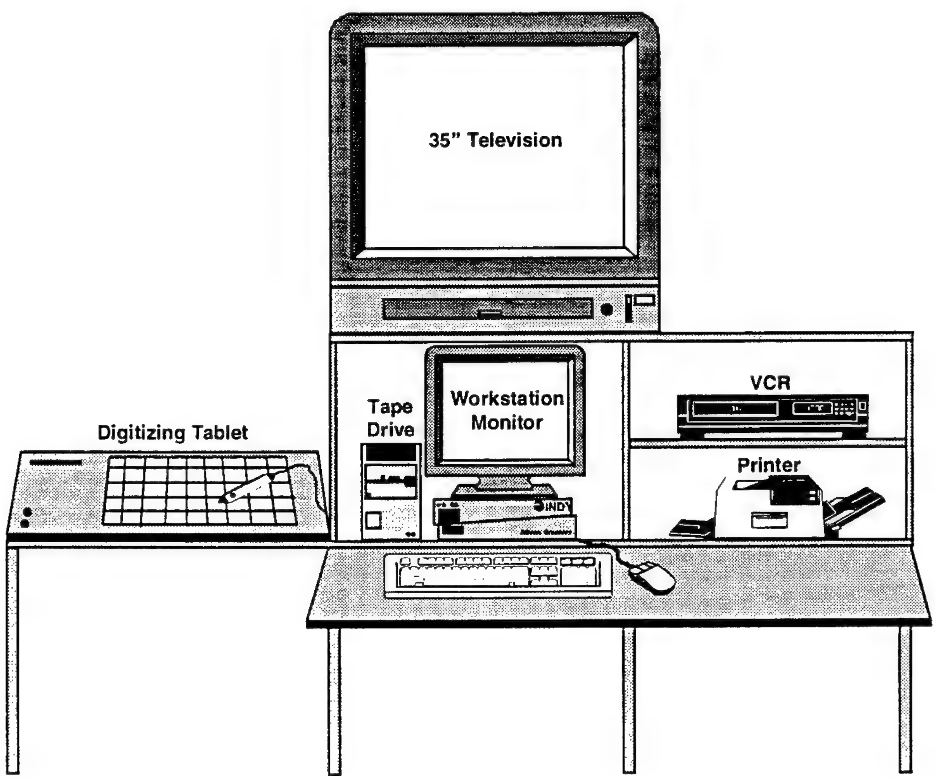


Figure 2. ATAFS workstation.

ATAFS AAR Aids

ATAFS has the capability to create five types of aids: (1) Plan View Animation (PVA), (2) Snapshot, (3) Battle Flow, (4) Fire Fight, and (5) Statistical AAR aids. Explanations and examples of each aid are provided in the following paragraphs.

The PVA AAR aid (Figure 3) displays a moment-by-moment animated replay of vehicle movement, tube and chassis orientation, direct and indirect fire vectors, and target kills, hits and misses. ATAFS also captures voice traffic from the tactical communications net and synchronizes play back of audio with the PVA display of computer-gènerated graphics. A PVA is useful for depicting unit movement, formations, engagements, and tactical voice communications.

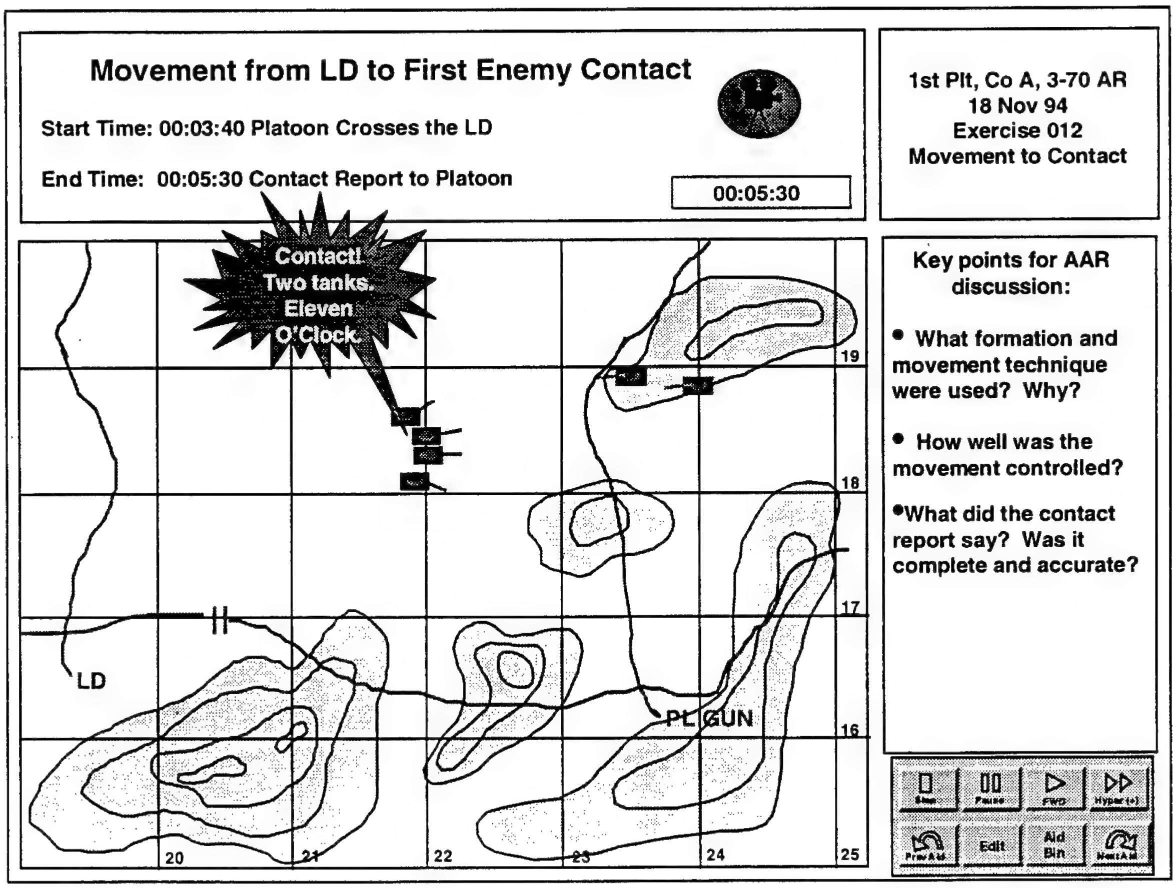


Figure 3. Plan view animation AAR aid.

All ATAFS AAR aids are formatted similarly. The top-center portion of the AAR aid indicates the title of the aid, the times associated with the beginning and ending of the aid (expressed in terms of time elapsed in hours, minutes, and seconds), and the tactical events associated with the beginning and ending times.

The aid illustrated in Figure 3 provides a moment-by-moment replay of the unit's activities and voice communications focusing on the movement of the platoon from the Line of Departure (LD) until first contact with the opposition force (OPFOR).

The top-right portion of the aid provides player and exercise administrative data. The middle-right portion of the aid provides open-ended questions or key teaching points the O/C may use to promote discussion among the players during the AAR. The lower-right portion of the aid provides control buttons the O/C may use to manipulate playback of the aid, edit the aid, or move to another aid. The map occupies the largest portion of the AAR aid and depicts the unit's activities between the starting and ending events.

The Snapshot AAR aid (Figure 4) depicts a freeze-frame view of player activities during the exercise. Snapshot AAR aids can be useful to show unit formations and tube and chassis orientations for a specific instance in time or to portray a specific aspect of an incident such as the shooter, target, and direct fire vector of a fratricide or near-fratricide incident.

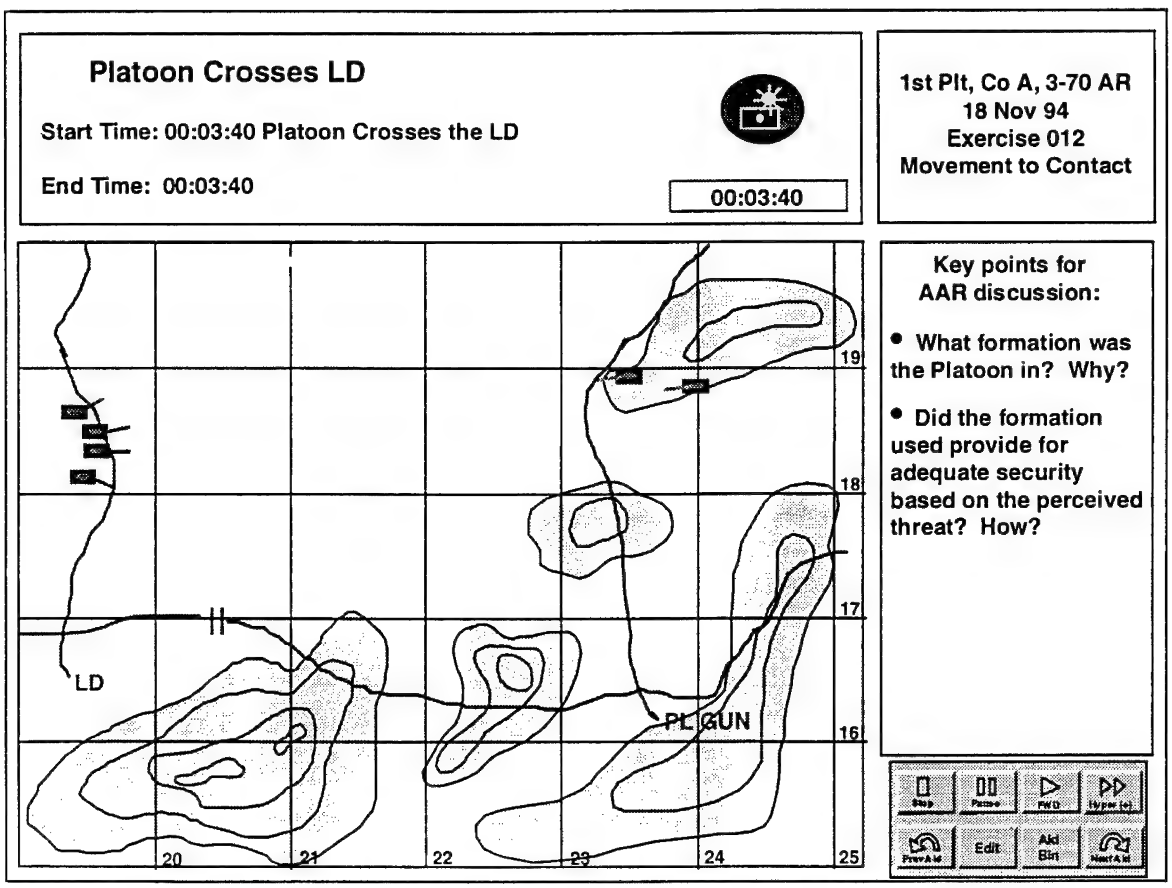


Figure 4. Snapshot AAR aid.

The Battle Flow AAR aid (Figure 5) depicts a trace (snail trail) of each vehicle's movement over time. The trace behind each vehicle contains tick marks, lines, and numerals that are color coded for each individual vehicle. The tick marks depict the position of the vehicle at one minute intervals. The numerals appear at each 5 minute interval. The O/C could use the Battle Flow below to make the teaching point that the player platoon took a very circuitous route to its on-order battle position and, as a result, was not in position to overwatch the disengagement and movement of its sister platoons to alternate battle positions. The Battle Flow is effective in showing a unit's movements when it become disoriented. For example, if the unit loses it way to the LD, the Battle Flow can show the unit's wanderings and the terrain features that the unit could have used to assist in its land navigation.

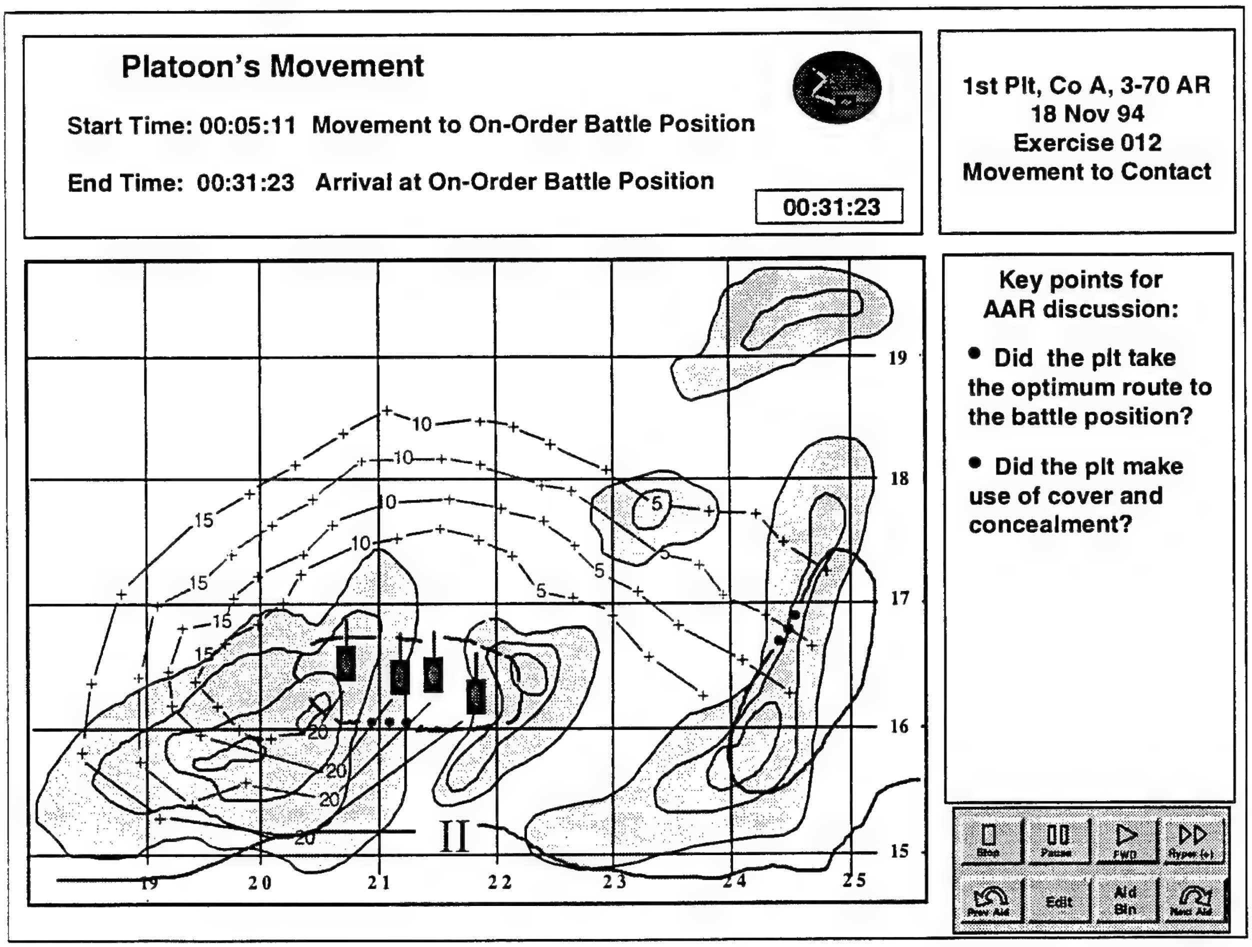


Figure 5. Battle flow AAR aid.

The Fire Fight AAR aid (Figure 6) provides an animation similar to the PVA but the direct fire vectors remain on the screen throughout the duration of the animation. Hits are indicated by a solid line, and misses are indicated by a broken

lines. This AAR aid permits players to compare their actions with the instructions in the battle drill and to determine who participated in the fire fight and who did not. The aid also permits the O/C and the players to determine where fires were massed and where they were not. This aid is more effective in defensive scenarios than offensive scenarios. In the defense, the players are relatively static and the O/C can readily correlate direct fire vectors with the firing vehicle. In the offense the O/C may not be able to pair vectors with the firing vehicles since the vehicles are moving. Fire Fight aids that are long in duration tend to become cluttered with vectors and are not useful for the AAR presentation. The O/C may shorten the time period covered by the Fire Fight aid which will reduce the number of direct fire vectors and declutter the aid. We explain how the O/C may adjust the duration of the aid's playback when we discuss the AAR Aid Editor later in this report.

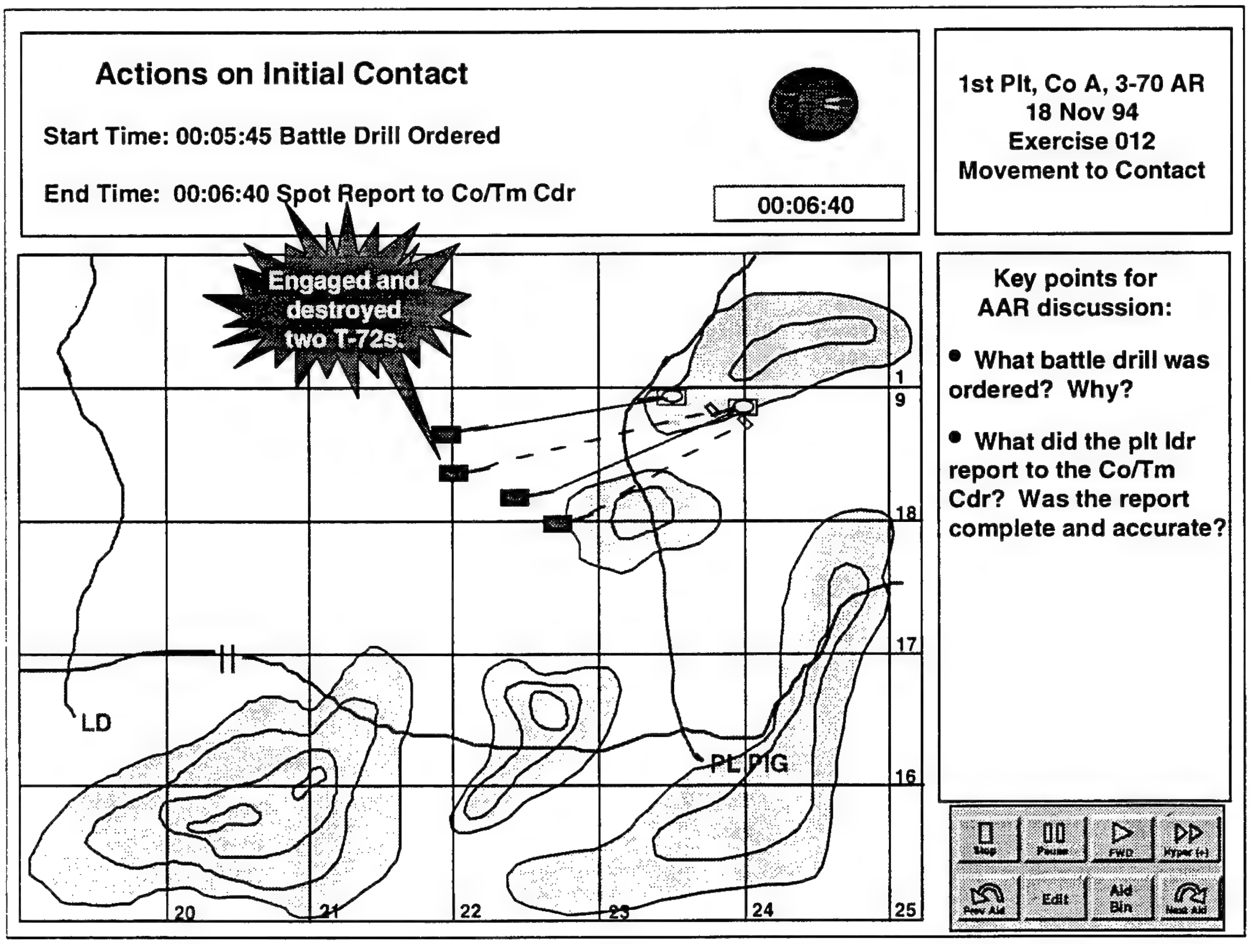


Figure 6. Fire fight AAR aid.

ATAFS generates statistical AAR aids in the form of tables and graphs based on rules embedded in system's knowledge base.

See Figures 7 through 10 for types of statistical aids produced by ATAFS.

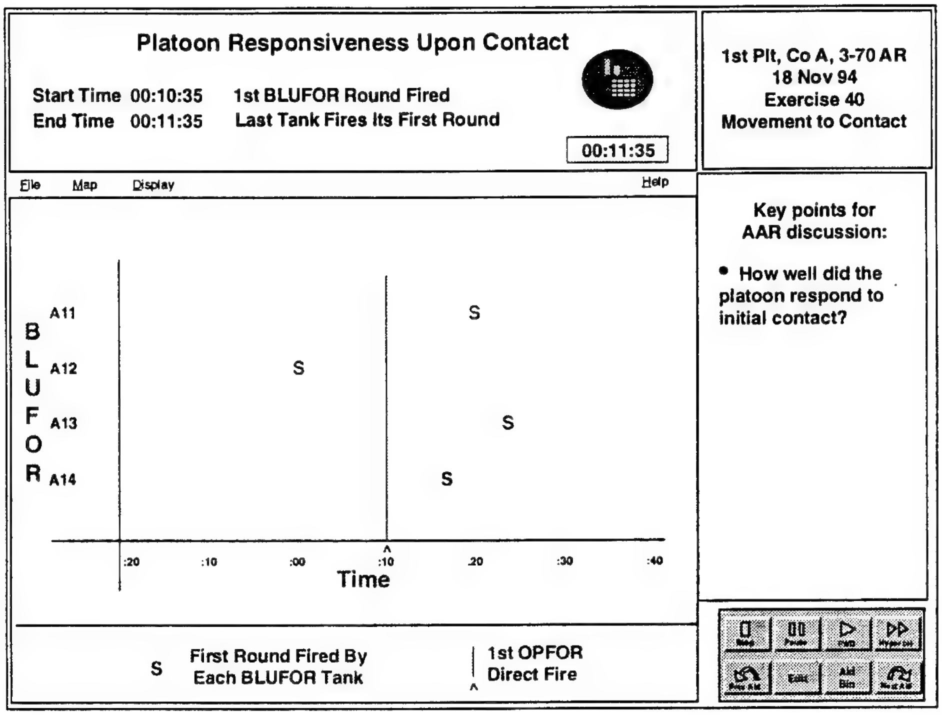


Figure 7. Platoon responsiveness upon contact.

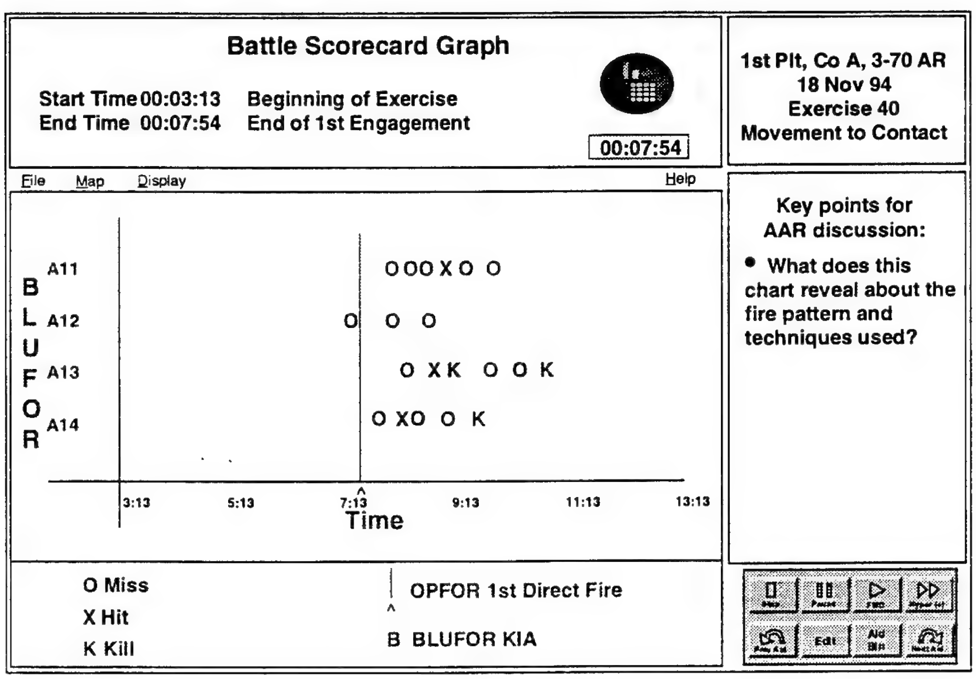


Figure 8. Battle scorecard graph.

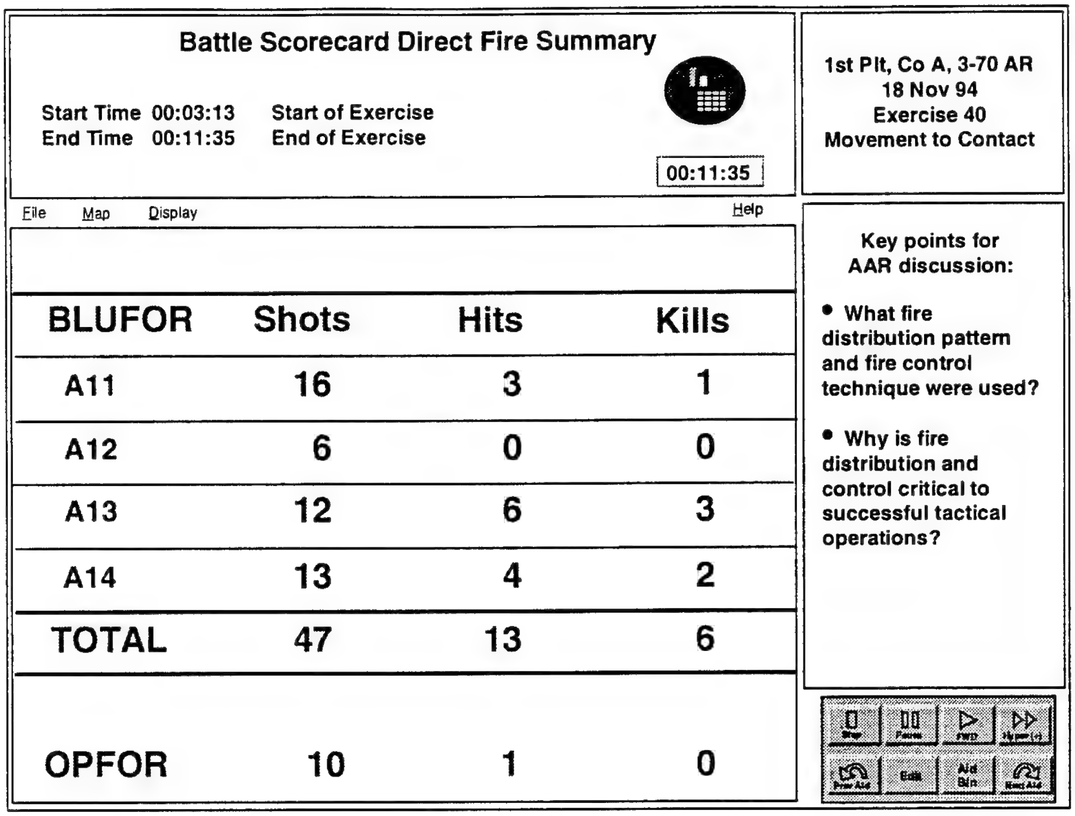


Figure 9. Battle scorecard direct fire summary.

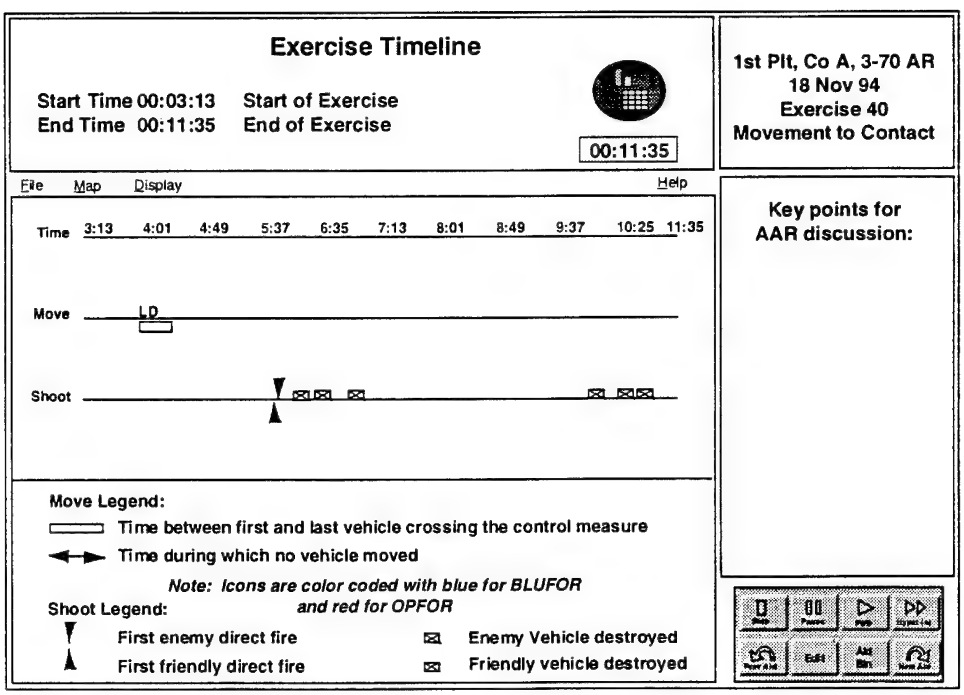


Figure 10. Exercise timeline.

Exercise Monitor

The Exercise Monitor (Figure 11) provides the O/C the capability to monitor the exercise in near-real time or in exercise history, to create custom/manual AAR aids in addition to those aids automatically produced by the system, and to notify ATAFS of those tactical events that the system cannot detect. For example, ATAFS has no voice recognition capability, so the system relies on the O/C to recognize significant tactical voice communications among the players and inform the system of these communications. The Prompts window on the right side of the Exercise Monitor contains the events that the O/C is responsible for detecting. The O/C simply clicks on the button adjacent to the prompt upon detecting the event, then the OK button, and ATAFS builds the AAR aid(s) pertinent to the event in the background as the O/C continues to monitor the exercise.

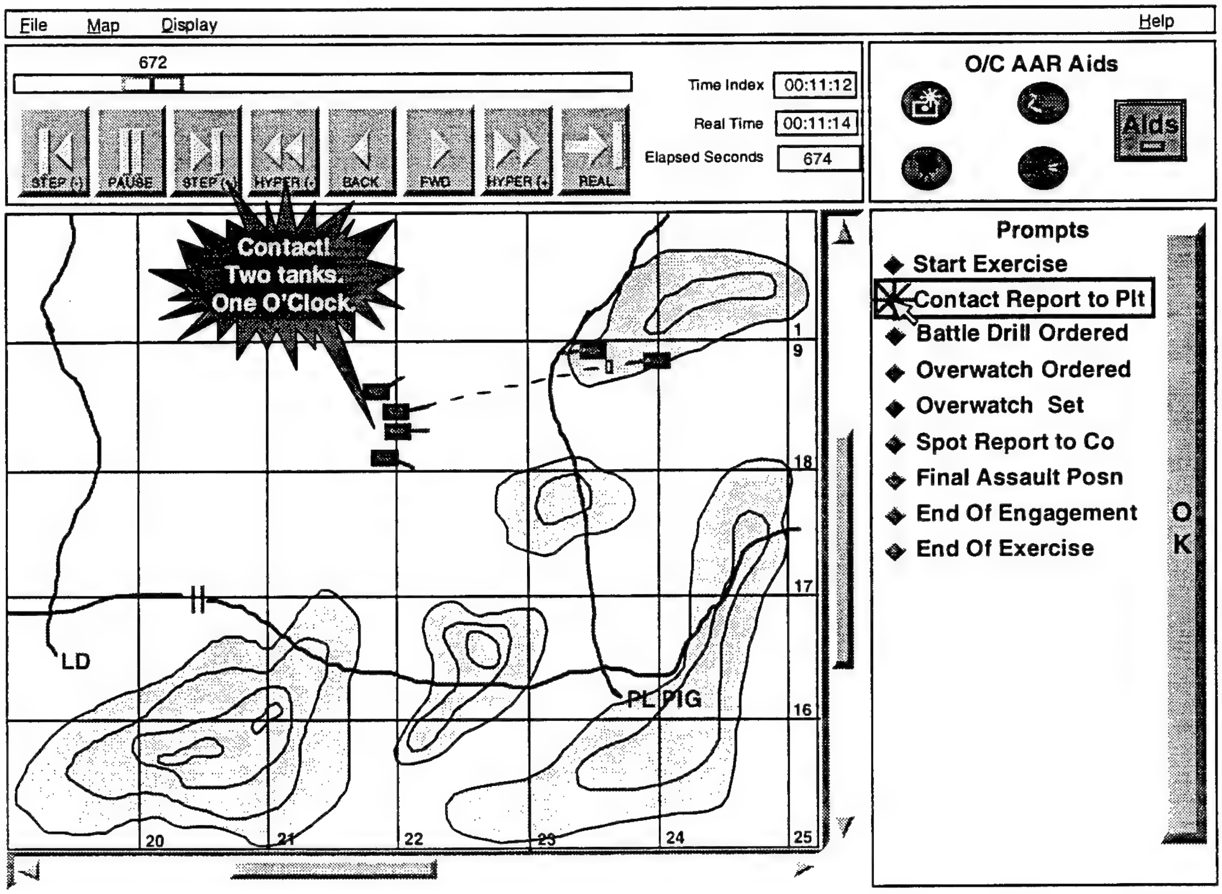


Figure 11. ATAFS exercise monitor.

AAR Aid Bin

ATAFS stores all AAR aids prepared automatically by the system or manually by the O/C in the Aid Bin. See Figure 12. The upper window (All Aids) contains all the aids prepared during the exercise. The O/C moves aids selected for the AAR or THPs from the upper window to the lower window (Aids for AAR/THP). Buttons along the bottom left of the lower window provide the O/C the capability to play and display the aid, edit the aid, and remove the aid from the AAR presentation. Buttons along the bottom right of the lower window allow the O/C to copy AAR aids and synchronized tactical voice communications to the VCR tape for the unit's THP, to print static aids such as Snap Shot or statistical aids, and to return to a near-real time or historical view of the exercise.

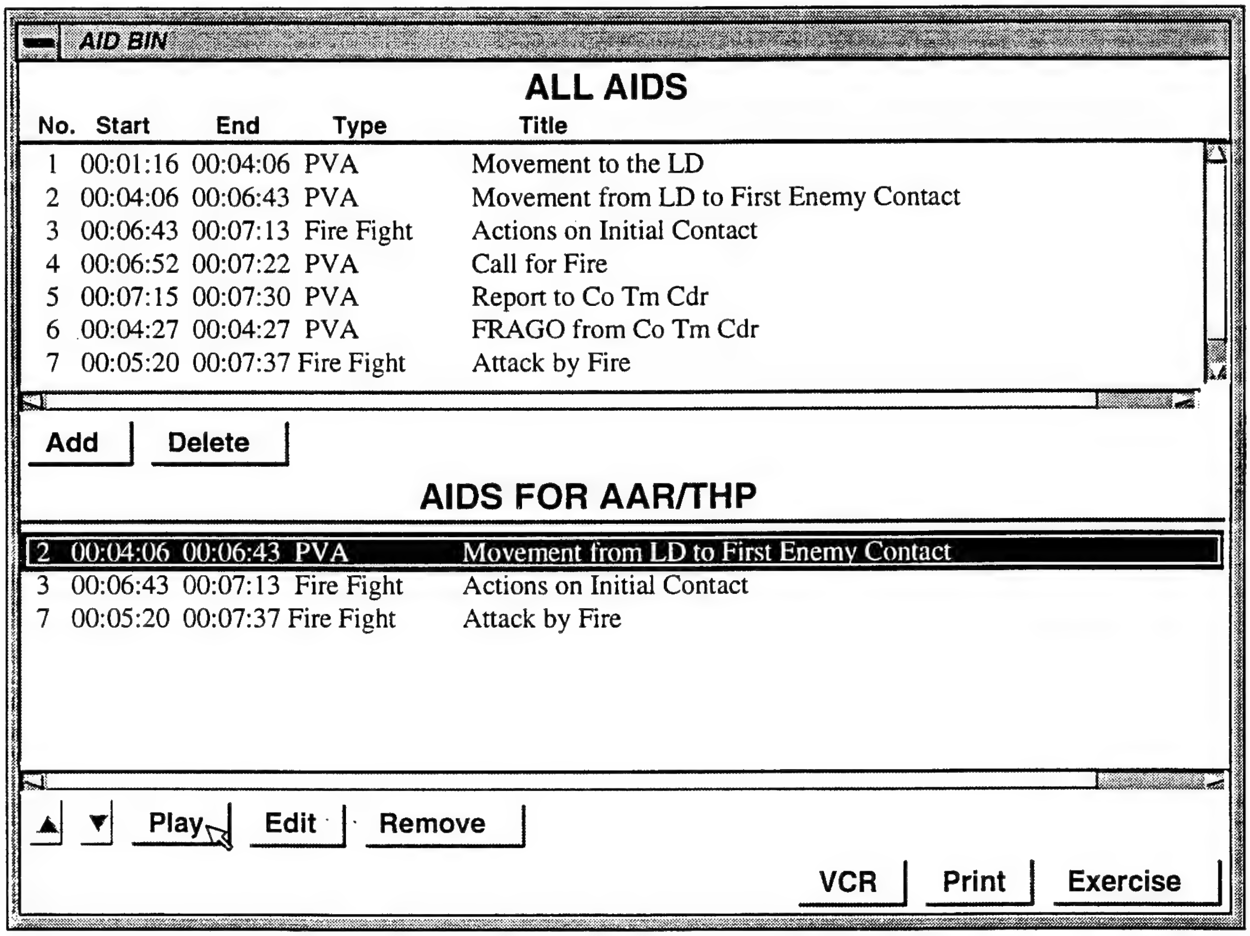


Figure 12. AAR aid bin.

AAR Aid Editor

The O/C may modify aids by using the AAR Aid Editor (See Figure 13). The O/C may modify the text in any of the windows with a white background, by highlighting the text to be corrected, then deleting or overwriting the unwanted text. This permits the O/C to change the title of the aid, the description of the tactical events that begin and end the aid, and the questions to pose to the AAR audience to generate discussion. The O/C may change the start and/or end time for the aid to alter the duration of the aid and the player activities portrayed. For example the O/C may wish to capture a call for fire made by the platoon sergeant which occurred after the contact report was rendered. In the example below the O/C would change the time appearing in the End Time window to extend the playback of the aid to include the platoon sergeant's call for fire.

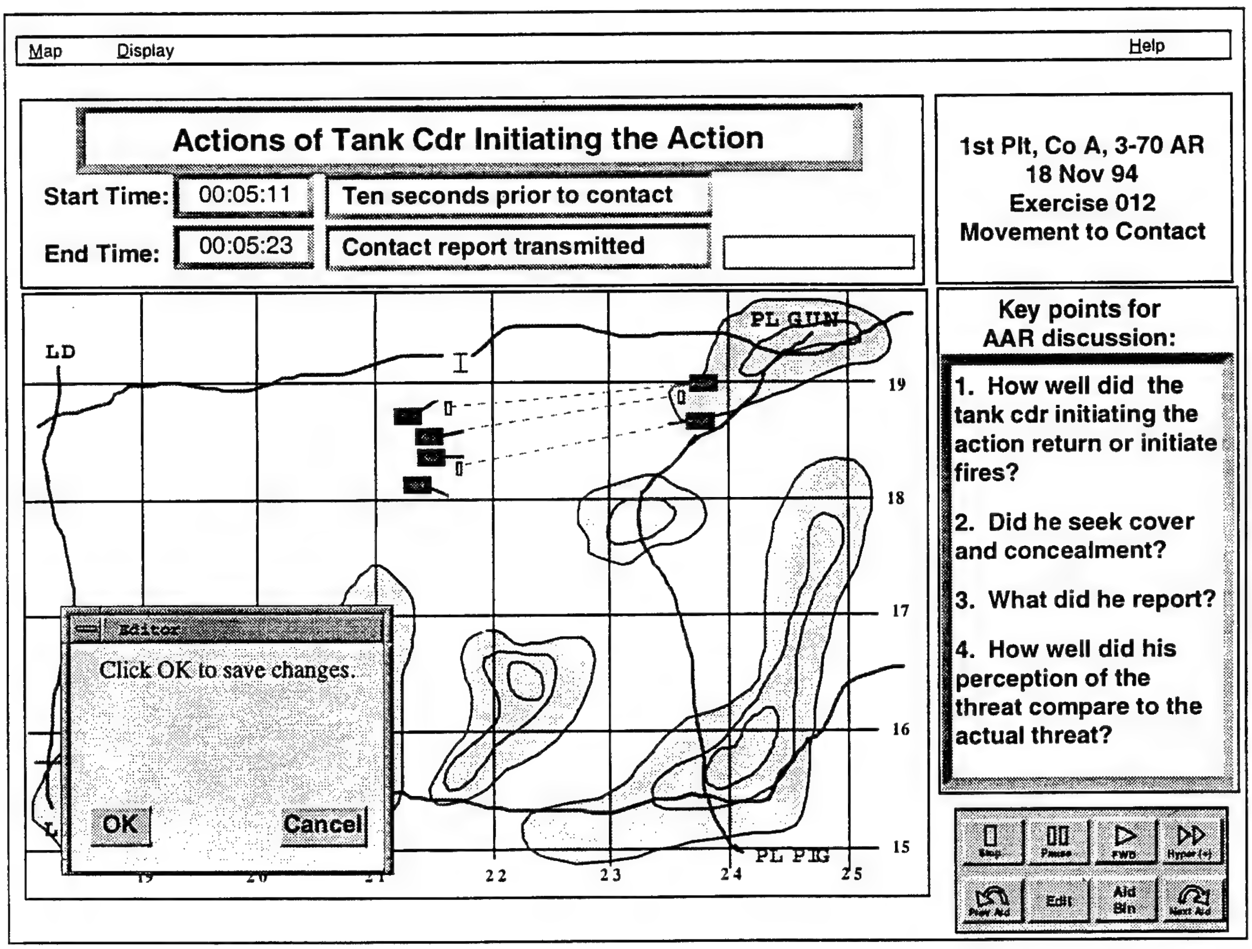


Figure 13. AAR aid editor.

Porting ATAFS to a New Hardware Platform

This portion of the project had to be integrated with the existing Phase II SBIR effort to demonstrate the ATAFS concept. When the Phase III effort was initiated we had already demonstrated the capability of ATAFS to support automated generation of AAR aids and also allow the user to move back in history during exercises and manually create AAR aids; however, the AAR aids included in the demonstration were limited to the PVA, Snapshots, and the Firefight. We added the Battle Flow (BF), graphs, data summary tables, and the Exercise Timeline after we ported the existing ATAFS to a new hardware platform. In addition, the AAR Aid Editor and the utility for creating THPs were added to ATAFS in the integrated Phase II/III effort.

We ported ATAFS from its proof-of-principle Amiga platform to the UNIX environment and used the SGI Indy workstation for increased performance. We purchased the commercial-off-the-shelf (COTS) hardware and software listed in Table 1 below to port ATAFS to UNIX, install the system at seven sites, and support software development.

Table 1.

ATAFS Workstation Hardware and Software

ITEM/DESCRIPTION	QUANTITY
Indy Computers 10	10
32 MB RAM	10
External 4G tape drive	10
20 " stereo monitor	10
External SCSI CDROM	10
Case Vision/Clear Case	6
ProDev Workshop Programming Enivronment	5
IRIS Development Option	5
C++Compiler	5
Network file system	10
SCSI cables	10
Scan converters	8
Digitizing tablets	8
Oracle	8
Printer-laser	8
VCR	8
Color TV (35")	6
Color TV (19")	2

We purchased all equipment in complete sets to avoid problems in hardware incompatibility. For example all 35-inch televisions are Zenith television sets and are the same model. As the shipments arrived at LB&M, we tested all hardware and software for proper operation and functioning and corrected any noted deficiencies through the vendor.

Within five months after contract award, we ported the ATAFS application to the SGI workstation. Thereafter, we improved the application based on user and SME feedback. Below are the tasks we accomplished in porting ATAFS from the Amiga platform to the SGI UNIX environment:

(1) Modified the LB&M Software Engine. The LB&M Software Engine provides the engine to execute ATAFS object-oriented programming. We rewrote the internal message-passing mechanism of the LB&M Software Engine for the SGI workstation. For increased speed, we used IRIX shared memory in place of the Simple Sockets Library implementation used for the Amiga platform. In addition, we reworked timer facilities to provide for finer timing accuracy. When appropriate, we updated software engine objects to take advantage of the additional capabilities available under the more powerful, sophisticated SGI platform.

(2) Rewrote Digitizing Tablet Driver. The Amiga digitizing tablets were not supported by SGI. We purchased Hitachi digitizing tablets and the Hitachi driver for SGI's IRIX operating system 5.3, then modified the driver to meet ATAFS resolution requirements.

(3) Revised Audio Playback/Recording. We redesigned audio support to interface with SGI hardware. We re-examined issues such as the sample rate and re-implemented as necessary.

(4) Implemented Video Output for the SGI Platform. We implemented support for the video hardware on the SGI platform. Unlike the Amiga platform, the SGI requires that ATAFS software directly control the video output hardware.

(5) Rewrote the Ethernet Device Driver. We rewrote the low-level interface to the Ethernet hardware to comply with the UNIX System V Release 4 application program interface. This rewrite included access to the hardware and primitive filtering of the SIMNET protocol data units.

(6) Integrated Oracle Database Application. We revised several ATAFS software objects implemented for the proof-of-principle prototype to integrate the Oracle application, which supports ATAFS' statistical AAR aids and the BF aid.

(7) Upgraded ATAFS User Interface. We also found many situations in which the functionality developed to demonstrate proof-of-principle was insufficient to support the ATAFS user. We rewrote unwieldy user interfaces and associated code to facilitate user acceptance.

Developing the POI

In developing a POI to meet users needs, we found that (a) potential ATAFS users ranged in rank from Major to Staff Sergeant, (b) their tactical and technical experience varied considerably, (c) the users may or may not be computer literate, and, (d) assigned ATAFS operators may have considerable to no previous experience in preparing AARs for virtual simulation exercises. For example, many ARNG units appoint members of the unit to serve as O/Cs for weekend exercises. These unit-appointed O/Cs may operate ATAFS only once or twice every six months. However, these O/Cs must be ready to operate an AAR system, to which they have limited access, almost immediately after arrival at the training site to support unit training. This forces unit-appointed O/Cs to quickly learn or relearn how to use ATAFS. Developing a POI that would permit unit-appointed O/Cs to achieve proficiency with ATAFS without substantial hands-on training on the actual system posed a major challenge. To meet this challenge, we developed an ATAFS multimedia, CBT POI on Compact Disk-Read Only Memory (CD-ROM) using personal computers (PC) to support O/C training (LB&M, 1995d).

The CBT provides highly interactive lessons on ATAFS capabilities and equipment and provides hands-on training exercises to acquire and sustain the required ATAFS skills and knowledge. We employed a multimedia 486 MS-DOS (Windows) platform and used the Icon-Author application for our CBT development environment. The multimedia PC permitted ARNG O/Cs to learn how to operate ATAFS without using actual ATAFS equipment. We found that O/Cs achieved sufficient proficiency in ATAFS operations using the CBT to readily transition to the actual system and prepare unit AARs. In some instances, O/Cs were able to effectively use ATAFS to prepare an AAR after only a 30 minute demonstration of the system.

We purchased COTS hardware and software listed in Table 2 below to install the ATAFS POI at seven sites and to support LB&M's training development efforts.

Table 2.

ATAFS CBT Hardware and Software

ITEM/DESCRIPTION	Quantity
486 DX2/66 with VESA Local Bus	8
16 Meg RAM	
1GB SCSI HD	
17" monitor	
Quad Speed CD Drive	
Sound Blaster 16 MCDASP	
VESA LB Windows Accelerator Card	
SCSI Controller Card	
MS Windows 3.11 & MS-DOS 6.22	
ICON Author	1

Figure 14 provides an illustration of the ATAFS CBT Course Navigator. The Navigator annotates which lessons the O/C has completed and those lessons remaining to be taken. We have provided the Course Navigator here to show an outline of the interactive courseware.

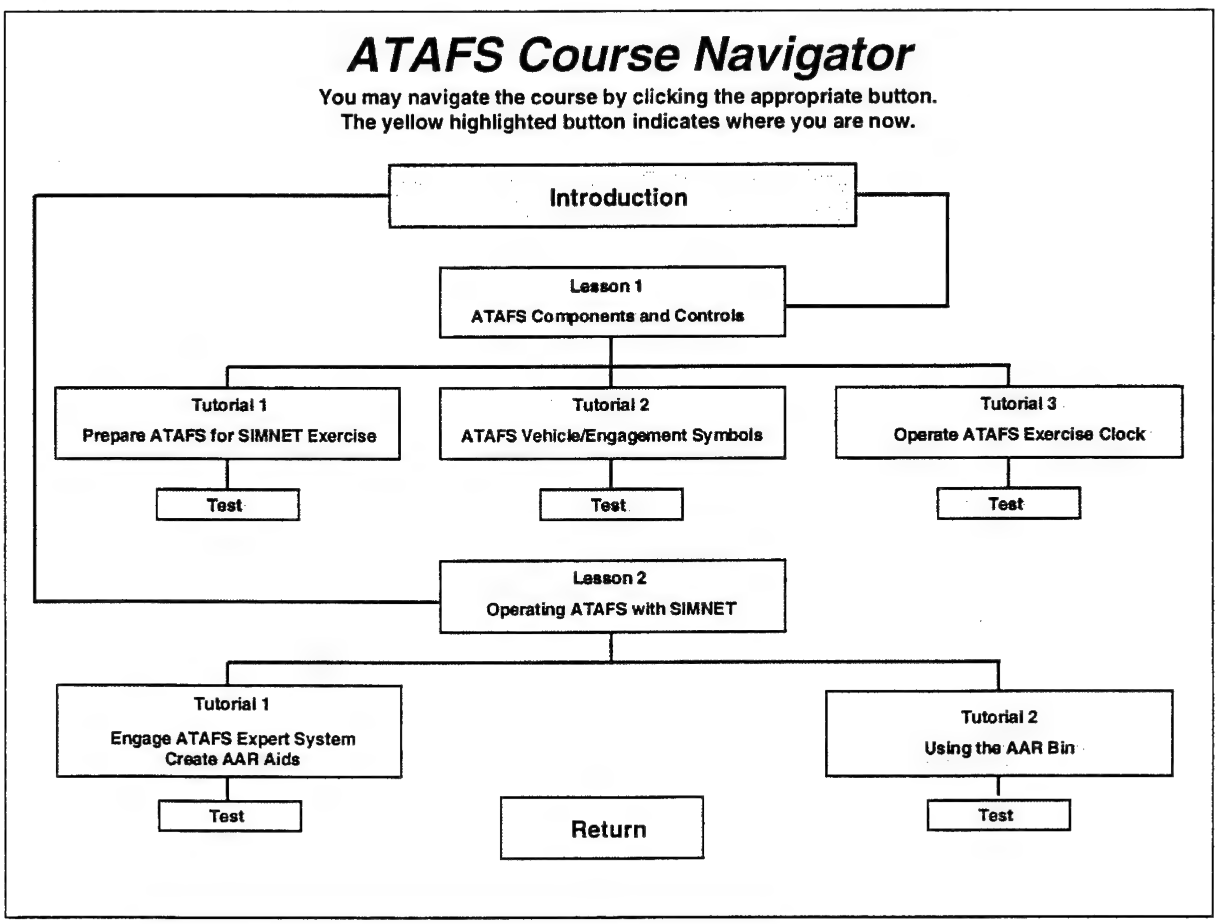


Figure 14. ATAFS CBT course navigator.

The introduction in the CBT provides an overview of ATAFS and how the system assists the O/C in observing and assessing player activities and preparing for the AAR. The remaining lessons and tutorials introduce O/Cs to the various components of the ATAFS workstation and walk them through each aspect of ATAFS operations from initialization of an exercise through final AAR and THP preparations. Each tutorial has an interactive test. If test results indicate that the O/C needs additional training, the CBT recommends that the O/C review the tutorial and complete the test a second time before proceeding to the next lesson.

We developed the CBT POI over three prototype cycles with the contracting officer's representative (COR) reviewing each prototype. We designed the CBT to support initial training and developed a user-controlled review to support sustainment training as well. We conducted beta testing of the CBT using members of the Fort Knox, KY WARTHOG O/C team. We found that O/Cs required 2 to 2.5 hours to complete the ATAFS CBT. All testers appeared to be impressed with the training package and offered constructive comments on how to improve the POI. Most of the comments were directed at the wording of the test questions at the end of each tutorial. Based on the beta test, we made final revisions to the POI prior to our first ATAFS installation. For more information on ATAFS user tasks, course strategy, and lessons for ATAFS user training see the Task/Learning Analysis and Lessons Specification Report (LB&M, 1995a).

We installed and integrated ATAFS at six simulation facilities designated by the DARPA SIMITAR program office. We installed a seventh ATAFS at the CCTT development facility in Orlando, FL, to support experimentation and testing for upgrades to the CCTT AAR system. At the SIMITAR designated sites we provided on-site training for O/Cs and the simulation facility staff. Some SIMITAR designated sites were equipped with mobile SIMNET vans while others were equipped with the DARPA Reconfigurable Simulator Initiative (ARSI) simulation suite developed by Texas Instruments (TI). Listed below are the sites where we installed and integrated ATAFS during the course of the project:

- Gowan Field, Boise, Idaho (M1 mobile SIMNET site)
- Griffin, Georgia (M2 mobile SIMNET site)
- Rome, Georgia (ARSI site)
- Helena, Montana (ARSI site)
- Bozeman, Montana (ARSI site)
- Fort Knox, Kentucky (Mounted Warfare Simulation Training Center)
- Orlando, Florida (CCTT)

A key difference between the ARSI sites and the other ARNG sites is that the ARSI sites use Distributed Interactive Simulation (DIS) Version 2.04 protocols (Institute of Electrical and Electronic Engineers, 1993) rather than SIMNET Version 6.6.1 protocols (Pope and Schaffer, 1991). Using the ATAFS at the ARSI sites required linking it to the exercise network through a DIS/SIMNET translator maintained on a separate workstation.

LB&M dispatched a New Equipment Training Team comprised of an SME/analyst and a software engineer to each simulation site. The team remained on site for four to five days to install and integrate the ATAFS workstation into the simulation facility, and to provide initial training to the facility support staff and O/Cs. The formal POI for ATAFS users included approximately two hours of CBT delivered on a multimedia PC and one-and-a-half hours of hands-on practical exercise using actual ATAFS equipment. During the practical exercises, two O/Cs sat behind the ATAFS workstation. One O/C served as the ATAFS operator and the other O/C served as an observer/coach to assist the operator in observing player activity, responding to prompts, and preparing the AAR. After the first practical exercise, the O/Cs switched positions, and the new ATAFS operator assessed player performance and prepared the AAR presentation. See Figure 15.

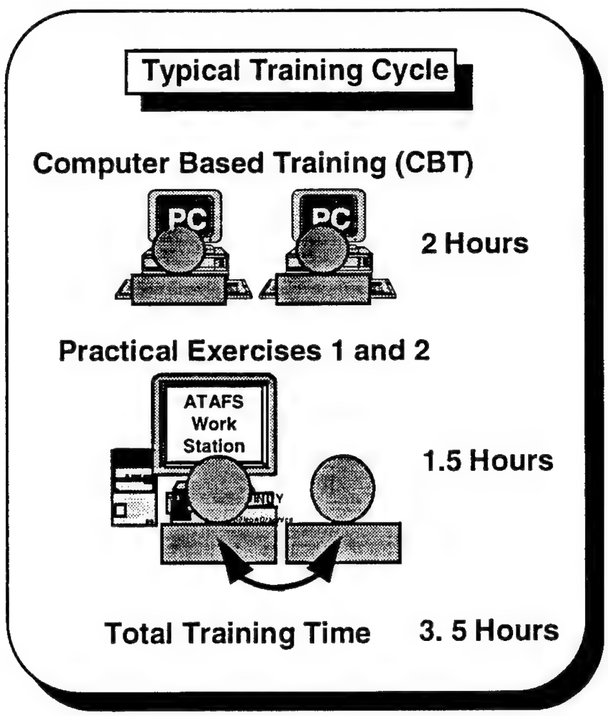


Figure 15. ATAFS O/C training cycle.

For the practical exercise, we used an archived exercise from a Simulation-Based Multi-echelon Training Program for Armor Units (SIMUTA) scenario that was executed by a unit participating in

the Reserve Component Virtual Training Program (RCVTP) at Fort Knox (Shlechter, Bessemer, Nesselroade, and Anthony, 1995). The exercise also contained the player unit's tactical communications traffic.

We shipped two PCs to each site. This allowed two O/Cs to complete the CBT POI concurrently. At the conclusion of the training, one PC was left at the site for sustainment training and training of new operators.

As O/Cs observed the exercise during the practical exercises, we encouraged them to verbalize on the key teaching points for the AAR. Based on the O/C's key teaching points and the receptiveness of the O/C to suggestions, we made comments such as: "You may want to consider deleting AAR aids 2 and 3 and retaining the other aids based on the key teaching points you established for the AAR." We used similar techniques to persuade O/Cs to consider the features offered by another AAR aid if the manual aid they built did not adequately support their key teaching point(s). Using this approach, participants appeared confident in their ability to operate ATAFS after about an hour of hands-on training.

Expanding ATAFS' Expert System

Under the Phase II SBIR contract, we performed proof-of-principle demonstrations of ATAFS' capability to automate AAR aid production using a sample tank platoon task: "Execute Actions on Contact." One of our objectives during the Phase III contract was to extend ATAFS' automated AAR aid generation to other tasks. We identified all tank platoon tasks trainable in SIMNET (Burnside, 1990), organized them into three mission groupings (Movement to Contact, Defense, and Tactical Road March), then developed algorithms for the generation of appropriate AAR aids based on player unit actions and inactions. We also refined our methodology for the construction of ATAFS rule sets and documented the front-end analysis performed by SMEs (LB&M, 1996b).

As SMEs completed their analysis for each mission, software engineers implemented rule sets using the C Language Integrated Production System (CLIPS). After implementation, SMEs observed the AAR aids produced by each rule set using Modular Semi-Automated Forces (ModSAF) and datalogger tapes of previously recorded exercises. Based on this review, SMEs and software engineers revised the rule sets as required. Next SMEs showed the AAR aids produced by the rule set to members of the WARTHOG O/C Team using the ATAFS installed in the Mounted Warfare Simulation Training Center at Fort Knox. Following the WARTHOG review, we made final revisions to the rule sets and distributed ATAFS software revisions. We performed this review cycle for each platoon mission. The methodology we employed in our analysis of each tank platoon tactical mission is described in a later section of this report, where we discuss the ATAFS-AT and how to perform the front-end analysis to use the tool.

Improving ATAFS User Interface and Functionality

During the course of the project, we received feedback on ATAFS' user friendliness and functionality as we installed the system at the seven sites designated by the DARPA SIMITAR office and demonstrated the system to various audiences. Current and potential customers and users were impressed with ATAFS' capability to relieve the burden on the O/C during AAR preparations and the capability of the system to provide a comprehensive AAR presentation immediately following exercise termination. Developers of the STAARS concept saw several of their visions for STAARS embedded in ATAFS (Meliza, 1996). Developers of the CCTT prepared an action plan to integrate ATAFS functionality into the CCTT AAR system pending the availability of funding. We also received many recommendations on how to make the system better. Based on these recommendations, we implemented many changes to ATAFS' graphical user interface (GUI) and added functionality to the system. However, there were many recommendations we were unable to implement during the project due to funding constraints. In the paragraphs that follow, we describe each upgrade we made and were unable to make to the system and what the user gains from the upgrade.

User Recommendations Implemented

Below is a listing of system upgrades we were able to accomplish during the course of the project. We focused our attention on addressing problems with the ATAFS estimated to have the greatest impact on the ability of trainers to use the system.

(1) Exercise Initialization. Our initial design of the dialogue box for system initialization (Figure 16) required that the O/C manually enter the date and time. Users were continually confused on what format to use to enter the date time group. We modified the initialization software and now ATAFS automatically enters the date and sets the time. The time is set to a default of 00:00 hours. O/Cs preferred this default time setting to local or Zulu time because they liked to mark events by hours and minutes into the exercise.

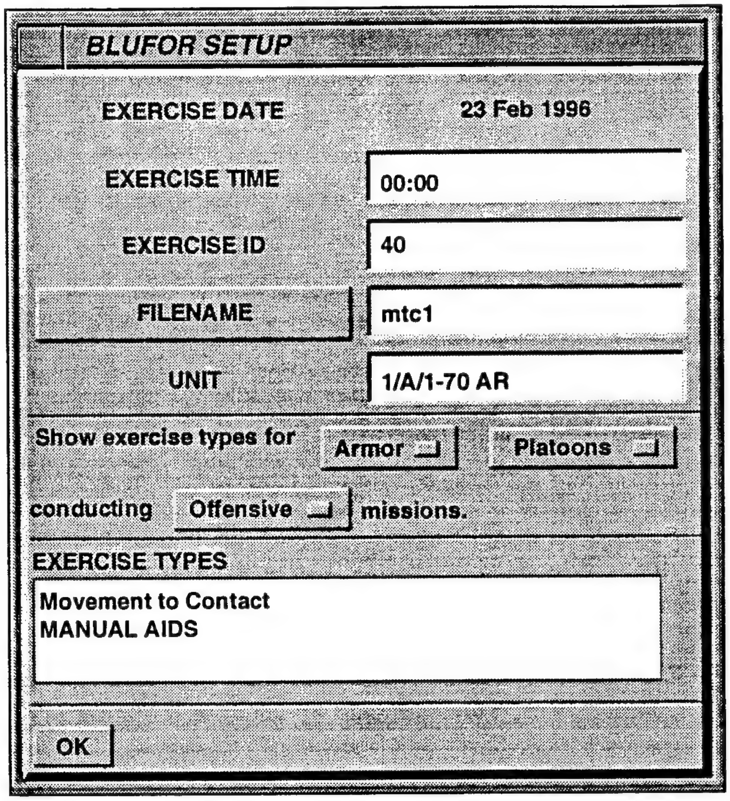


Figure 16. Exercise initialization.

(2) Data Storage. During installations in Georgia and at Fort Knox, KY, it became clear that ATAFS storage space for exercise data was inadequate. An exercise longer than 45 minutes would fill up the hard drive and cause ATAFS to cease functioning. Soon thereafter the government provided LB&M authorization and funds to equip all sites with a 4 gigabyte hard drive. This upgrade increased storage space for exercise data from approximately 45 minutes to 8-10 hours.

Users requested that ATAFS provide them a gauge indicating the amount of disk space remaining for exercise storage before, during and after the exercise. Without this gauge there is nothing (other than through the entry of UNIX commands) to warn the O/Cs that they are running short of disk space. If the O/C exceeds disk space limitations, ATAFS will crash and the entire exercise will be lost. We developed a gauge that was color coded in red, amber, and green and visible to the user at all times. Green indicates there is two or more hours of storage space available; amber indicates there is one to two hours of storage space available; and red indicates there is less than one hour of storage space remaining. The gauge also provides percent of disk space used and the amount of exercise storage space available in terms of minutes. See Figure 17.

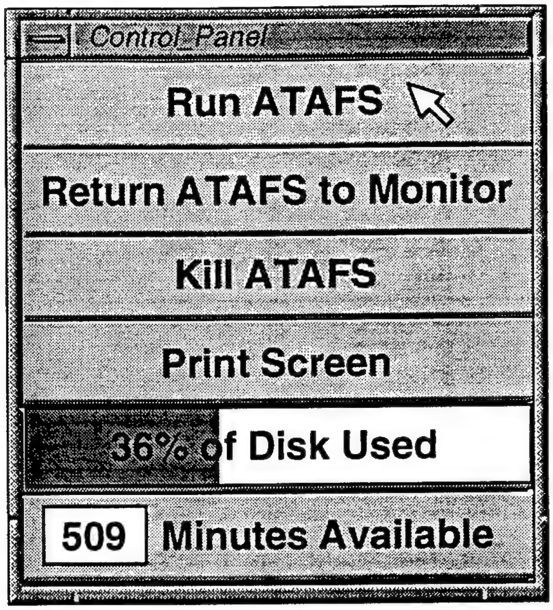


Figure 17. Disk space gauge.

(3) Time-Lag. During installation testing, we discovered that ATAFS progressively lagged behind exercise real time. For each 15 minutes of exercise time, ATAFS would lag behind approximately 45 seconds. The lag time became progressively worse as the exercise continued. This presented no major problems in preparing the AAR. However, the lag time caused a significant problem for the O/C in fulfilling exercise control responsibilities. We were able to correct the lag time problem through a combination of adjusting how the software maintains time within ATAFS and adding a buffering/cache function to the database to read ahead for the next one second update. These fixes reduced ATAFS lag time to approximately 3.5 seconds. The 3.5 second lag time in the O/C's "top-down" view of player activities had no impact on exercise control or AAR preparations. However, the 3.5 second lag time in tactical voice communications, caused by the system first recording the transmission then playing back the transmission, did impact on the O/C's control duty of role playing the company commander or an adjacent unit during the exercise. There was potential for the O/C to cut-off player tactical communications since the O/C was not monitoring or responding to player transmissions in real time. To solve the audio time-lag problem, O/Cs muted the sound coming from ATAFS and listened to the actual radios at their workstations during the exercise, so they could maintain a real-time awareness of player radio traffic. At the conclusion of the exercise, the O/Cs turned up the volume on ATAFS and muted the audio on the real radios, so they could hear the tactical communications that accompanied the visual replays of the exercise. The 3.5 second delay had no impact on the

synchronization of radio traffic with the replay of top-down views of player activities.

(4) Digitizing Tablet. ATAFS' digitizing tablet permits the O/Cs to trace the unit's overlay into the system, so they may view the player's activities in relation to the unit's tactical plan. See Figure 18. The digitizing tablet also allows the O/C to designate the control measures (e.g., the line of departure) needed by the expert system to generate AAR aids. We found that the software driver for the digitizing tablet did not exploit the drawing tablet's full resolution. Smoothly drawn lines appeared jagged on ATAFS screen and text was difficult to read. We were able to correct this problem through adjustments to the digitizing tablet driver.

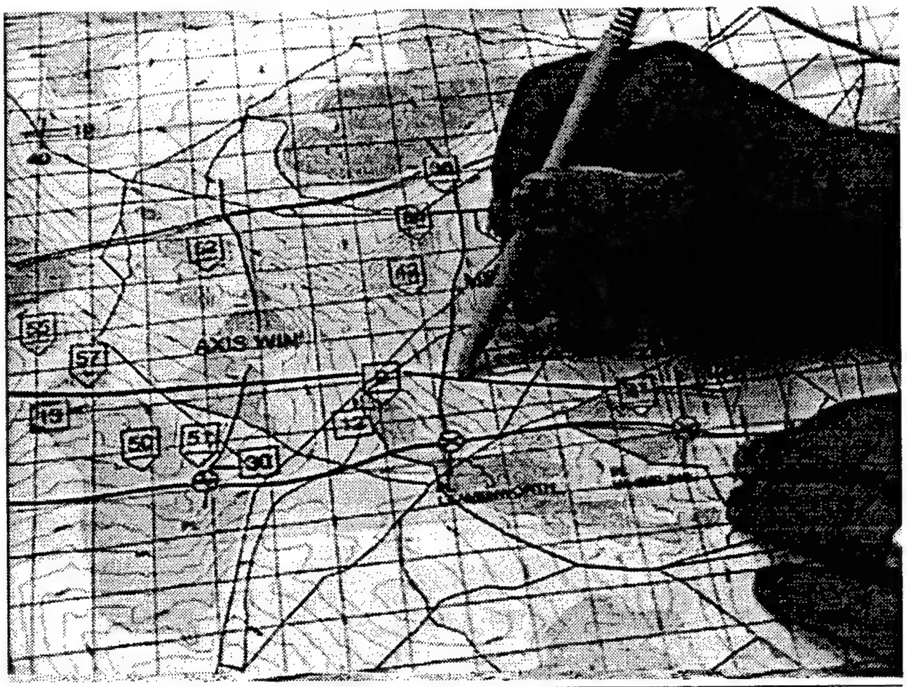


Figure 18. Digitizing tablet.

As initially configured, the stylus for the digitizing tablet was too sensitive. For example, the system informs the user to click on four points along the LD to designate the LD for the expert system. If the user held the stylus down too long when clicking on a point, the stylus would transmit multiple points confusing the expert system and the user. To correct the problem, we added user feedback (beeps) for each click of the stylus and added a minimum distance the operator had to move the stylus for it to become active again. The "beeps" boosted the confidence of users that they had designated points on the overlay correctly and that the system had accepted the input.

Feedback from users told us that ATAFS crashed when O/Cs entered extremely large overlays. We found that insufficient memory caused this deficiency. We corrected the problem by allocating additional memory for overlays.

During ATAFS installations and on-site training, SMEs recommended that ATAFS provide users with the capability to save the control measures they had designated to trigger automatic AAR aid production (i.e., the LD or an objective). ATAFS had the capability to save the overlay, but not the control measures designated by the O/C. We implemented this recommendation immediately since the upgrade eliminated the requirement for a digitizing tablet for each ATAFS workstation. Now, one digitizing tablet per simulation facility might be sufficient to support development of new exercise overlays and to designate the control measures that will trigger AAR aid production.

(5) Saving AAR Aids. ATAFS saved the exercise overlay, designated control measures for expert system rules, and all exercise activity from a completed exercise. However, ATAFS did not save the AAR aids created for the exercise since the aids could be loaded to VCR tape if the O/C wished to present the AAR later. O/Cs found this extremely inconvenient due to the time required to copy all aids to VCR tape. If an animated aid with tactical voice communications ran for four minutes, ATAFS would require four minutes to copy the aid to tape. If the combined running time of all aids planned for the AAR presentation was 20 minutes, ATAFS would require 20 minutes to copy the AAR to VCR tape. Users recommended that ATAFS have the capability to save an exercise complete with all AAR aids in addition to the overlay, control measure designations, and player activities. We implemented this upgrade during the final months of the project. Now, when the O/C quits ATAFS, the system automatically saves all AAR aids. The O/C has the flexibility to close the current exercise file, initiate another exercise, and deliver the AAR presentation for the first exercise at a later time.

(6) Designation of Friendly Force or Blue Force (BLUFOR) Entities for Automated AAR Aids. We designed ATAFS' expert system to monitor the activities of ModSAF opposing force entities and a player tank platoon comprised of four vehicles. Occasionally, O/Cs introduced ModSAF vehicles to simulate adjacent and supporting BLUFOR. These additional BLUFOR vehicles confused ATAFS' expert system and the system generated erroneous AAR aids. We also recognized that if the government chose to expand ATAFS' expert system to automate AAR aid production for the mechanized infantry platoon, scout platoon, air defense platoon, etc., that the system had to be flexible in the number of vehicles it would track for the generation of AAR aids. Users suggested that ATAFS provide O/Cs with the capability to

designate the vehicles they wished ATAFS to monitor for the purpose of the AAR. We implemented this upgrade and distributed the enhancement in the last ATAFS software version. ATAFS continues to display all BLUFOR and OPFOR activities on the "Exercise Monitor", however, ATAFS' expert system now produces AAR aids pertaining only to those entities designated by the O/C.

Figure 19 depicts the user interface window that O/Cs use to designate the vehicles for ATAFS to monitor. The number of vehicles appearing in the window depend on the number of vehicles designated by the O/C. Currently, the O/C may designate from one to ten player vehicles for monitoring by the expert system. During the exercise, O/Cs can cause the window below to appear for one or more vehicles so they may monitor speed of an individual vehicle or a tactical formation. If O/Cs wish to determine the call sign or bumper number of a vehicle, they simply click on the vehicle and a window similar to that below appears providing information on the single vehicle selected.

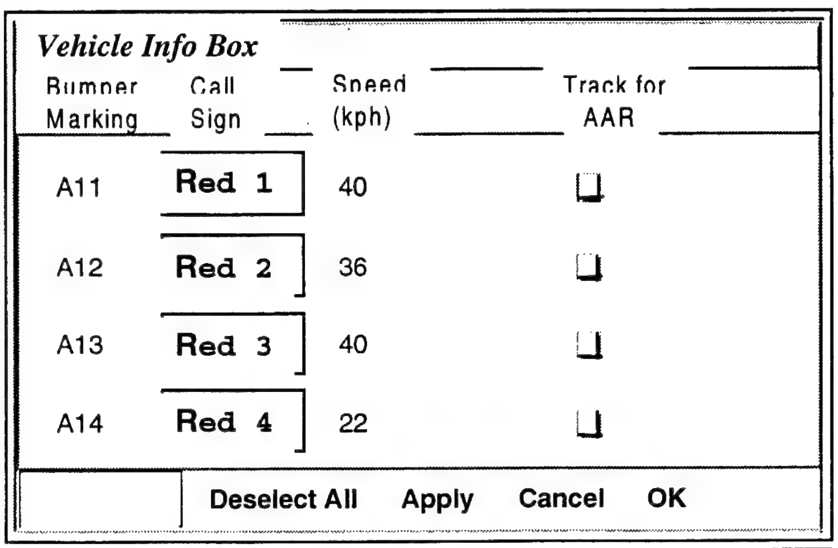


Figure 19. Designating vehicles.

(7) Replacement of UNIX Commands with a GUI. We found that O/Cs greatly disliked the task of typing UNIX commands to initiate a function. We relied on the user to employ UNIX commands to initiate a few functions within ATAFS. For example, we required the O/C to use UNIX commands to delete exercise files or to copy exercise files to tape. We discovered that O/Cs had to be trained over and over again on how to enter the commands. However, we found that if we developed an intuitive GUI, the O/Cs quickly learned how to use the interface and retraining requirements were minimized.

(8) Battle Flow AAR Aid. The BF AAR aid which portrays "snail trails" behind each vehicle was inoperable for the greater part of the project. O/Cs expressed a strong need for this aid and we successfully implemented, integrated, tested, and distributed the fix with the last ATAFS software version near the end of the project.

(9) Magnified AAR Aids. Users suggested providing a magnified image of the player's activities on the 35 inch TV screen for easier viewing by the AAR audience. In response we added the capability for the workstation to display the SGI Live Video Output window upon ATAFS start-up. Using the Live Video Output window, the O/C can focus the AAR audience's attention to a magnified view of the map area on the TV screen. The O/C may also move the window about the computer screen to project the desired view on the TV.

User Recommendations That Remain to be Implemented

During the course of the project we received many recommendations and suggestions to improve ATAFS that we were unable to implement due to project scope or funding limitations. Listed below are the recommended ATAFS upgrades we consider to be the most significant. We have listed the recommendations in priority with the most important at the top of the list. The priority assigned to each recommendation is not based on a survey of O/Cs. The priorities below are based on our perceived criticality of the upgrade to the user's needs.

(1) Upgrade to DIS Protocols. The most critical refinement for ATAFS is the development of a version that employs DIS PDUs rather than SIMNET PDUs. The CCTT and other new networked simulator systems employ DIS rather than SIMNET protocols. ATAFS needs to be upgraded so that it can be used in a DIS environment without the need to employ a separate work station running a SIMNET/DIS translator.

(2) Integration of Exercise Control and AAR Preparation. We found that the ATAFS we installed at ARSI sites were generally used by unit-appointed O/Cs and dedicated O/Cs to conduct AARs. ARSI sites are equipped with a datalogger for exercise playback, but units generally turned-off the ARSI datalogger and used ATAFS to record the exercise and prepare the AAR. At the Mounted Warfare Simulation Training Center (MWSTC) at Fort Knox, KY and at mobile SIMNET facilities, we collocated ATAFS with the existing SIMNET AAR system. We found that when O/Cs have two AAR systems available, that they will use one system and the other system will generally remain idle. We found that O/Cs, particularly those assigned to dedicated O/C teams, were well practiced and comfortable with the SIMNET AAR system. At MWSTC

At MWSTC an O/C and an Exercise Controller (EC) man the AAR station. The O/C uses the three-dimensional (3D) Stealth view to control the exercise and as the primary medium for the AAR presentation. (ATAFS does not have a 3D view since this feature was beyond the scope of the project.) The EC uses the two-dimensional (2D) view provided by the ModSAF console to view player activities from a top-down perspective and to control the activities of OPFOR and BLUFOR computer-generated forces. O/Cs and ECs recognized that ATAFS AAR products would complement 3D views and wanted to integrate ATAFS AAR aids into the AAR presentation, but found that operation of both systems was too unwieldy during the limited time available for exercise and AAR preparations. Consequently, O/Cs and ECs used the SIMNET AAR system with its integrated 3D view and ModSAF console. Figure 20 depicts the configuration of ATAFS and the existing SIMNET AAR system at MWSTC.

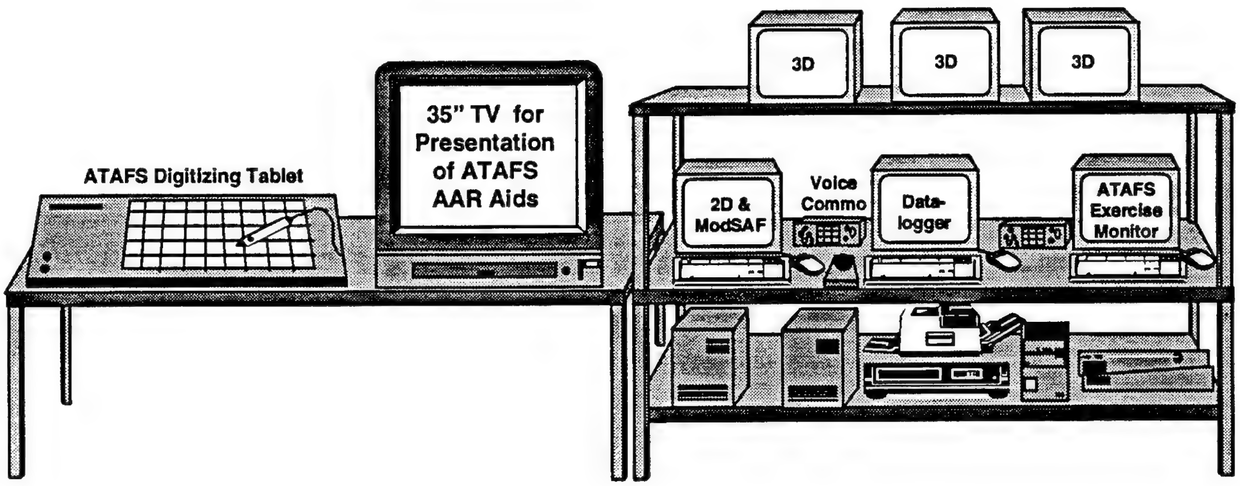


Figure 20. AAR console with SIMNET and ATAFS AAR systems.

Both the O/C and EC use tactical voice communications to perform control functions, i.e., role playing as the company team commander, scout platoon, or an adjacent platoon. As the exercise progresses the O/C annotates a notebook with X's and O's indicating which tasks were performed to standard and which tasks require improvement. When O/Cs observe a 3D view they wish to play back during the AAR, they note the time of the event appearing on the datalogger and annotate the time in a notebook. AAR preparations are second priority to control of the exercise. Failure of the O/C to direct a flank attack by OPFOR helicopters or to issue appropriate orders as the higher headquarters could impact adversely of the training objectives established for the exercise table. Consequently, O/Cs are highly attuned to their control duties and prepare the AAR as their control responsibilities permit.

The EC enters the operations overlay for the exercise using ModSAF's top-down view. If the overlay needed is an existing overlay for a particular exercise table, the EC recalls the overlay from a file of prepared overlays. In order to have the same overlay appear on ATAFS' top-down view, the EC or O/C must enter the overlay a second time using ATAFS's digitizing tablet to trace in the overlay. If the overlay already exists in ATAFS' overlay files, the O/C may simply recall the overlay and the overlay will appear on ATAFS' Exercise Monitor. Regardless of the procedure, the O/C or EC must perform duplicate actions to enter exercise overlays into both ModSAF and ATAFS (Meliza & Paz, 1996).

As you will recall in our discussion of ATAFS operations, ATAFS relies on the O/C to notify the system of those significant tactical events that ATAFS is unable to detect, such as those events initiated by tactical voice communications. For example, if O/Cs monitor a contact report, they notify ATAFS of the event by clicking on a Prompt button and continue to monitor the exercise as ATAFS constructs the AAR aid(s) in the background. Notice that there is a set of controls for each monitor on the middle shelf in Figure 20. There are three keyboards and three mice to operate. The requirement to respond to ATAFS prompts may require O/Cs to shift their attention from a 3D view they are using to observe and control the exercise and reposition themselves behind the ATAFS workstation so they may actuate the appropriate prompt. This activity is inconvenient and distracts the O/C from control duties during the exercise (Meliza, 1996).

What is needed is (a) an integration of ATAFS functionality with the 3D view, ModSAF, and the datalogger and (b) an integration of AAR preparation and exercise control functions that minimizes competition between the two functions for the O/C's attention (Meliza, 1996). See Figure 21 for a conceptual layout of an AAR station that integrates ATAFS and SIMNET AAR systems.

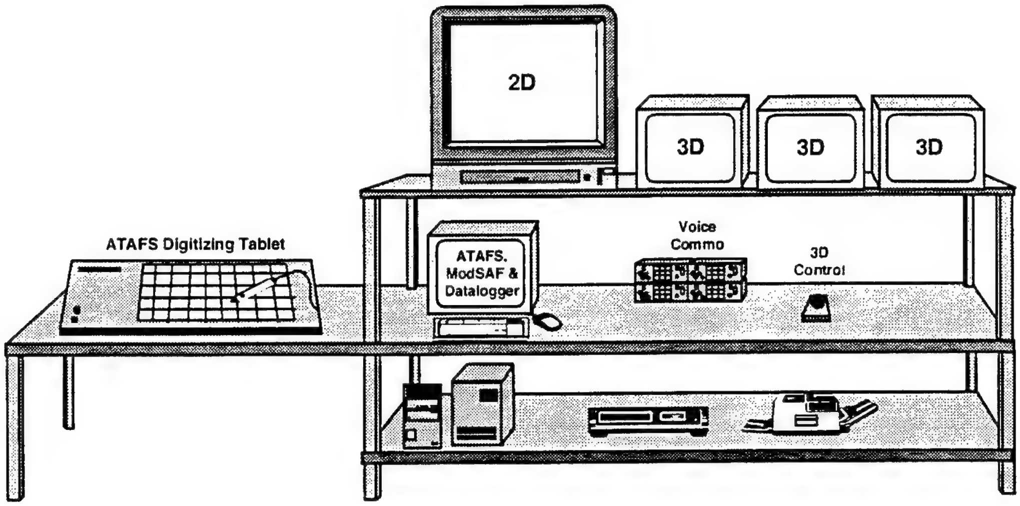


Figure 21. Integrating ATAFS functionality.

In the AAR workstation above the EC controls computer-generated force behavior, responds to ATAFS prompts, and controls replay of the exercise from the single computer console on the middle shelf. The O/C controls the 3D views on the top shelf and can also glance at the large 2D screen which provides a mirror image of the map area, operations overlay, and player activities as depicted on the EC's console. The EC enters new overlays into the system through ATAFS' digitizing tablet and recalls existing overlays from the EC console. (If the simulation facility uses exercise tables, only one to three digitizing tablets may be required to support the entire facility since most overlays will already be prepared for access from the EC's console.) The EC displays ATAFS statistical aids and aids depicting top-down views of player activity on the large 2D screen. ATAFS functionality is expanded to also automate preparation of 3D AAR aids which the EC presents on the 3D displays. In the AAR workstation configuration above, we envision that the EC will select, modify, and present AAR aids from the Aid Bin as directed by the O/C.

Figure 22 portrays the screen for the EC console. ECs have access to the ModSAF application. However, they also have access to the datalogger through the Exercise Clock which permits them to replay any segment of exercise history for viewing on 2D and 3D monitors. ATAFS Prompts are also visible so the EC may notify ATAFS when a specified event occurs (Meliza & Paz, 1996). In addition to the automated AAR aids prepared by ATAFS, the EC may prepare a Snap Shot, Battle Flow, Plan View Animation, or Fire Fight AAR aid manually by simply clicking on the button for that aid. For the Snap Shot, clicking once on the button will produce the aid. For the remaining aids, the EC clicks the button once to initiate aid preparation and clicks the button a second time

to conclude the aid. The system will capture the activity seen on the monitor from the time an EC initiates the aid to the time the aid is concluded. Notice that the EC may prepare manual 3D aids as well as ATAFS 2D aids. We envision the EC preparing manual aids based on directives and guidance from the O/C during and after the exercise.

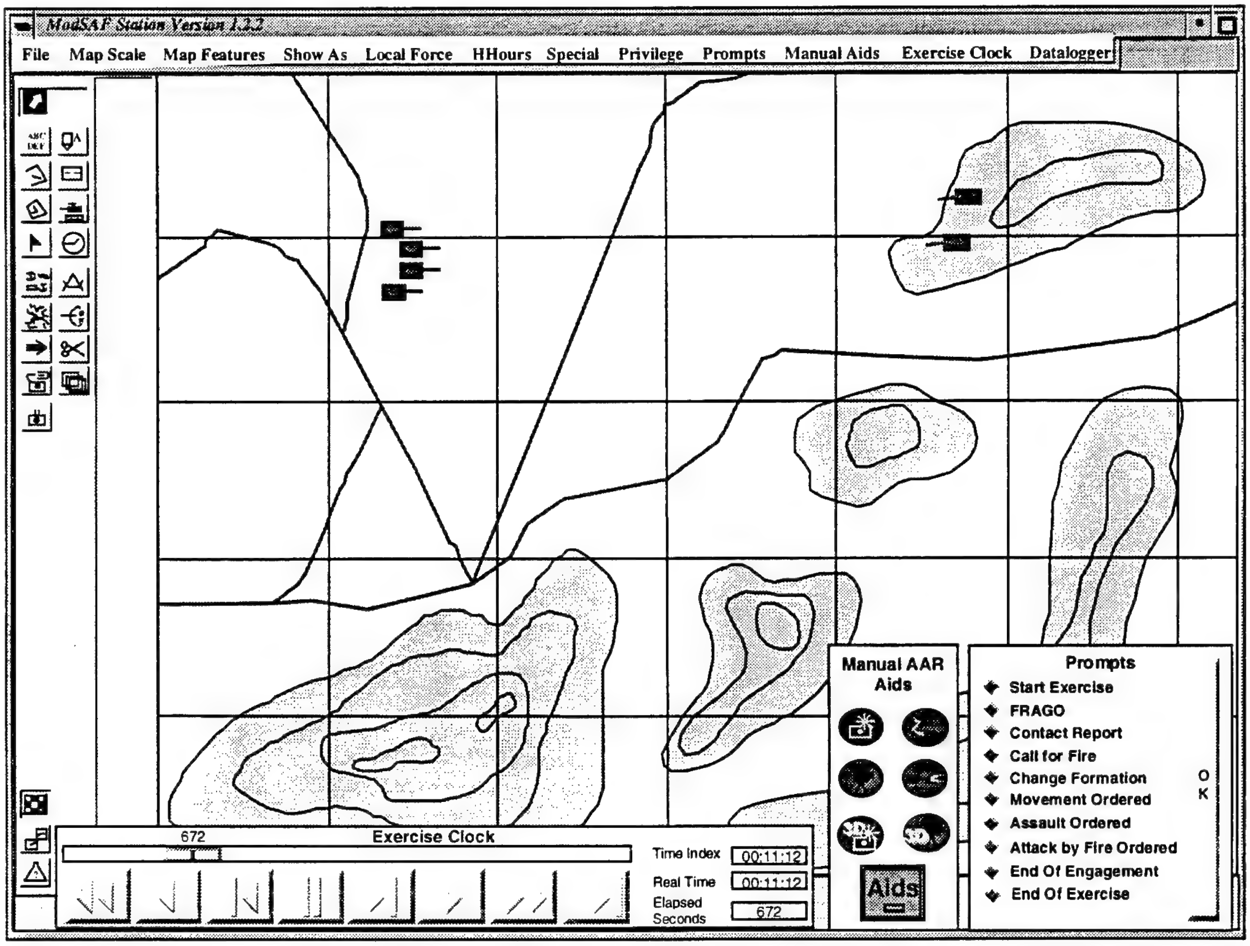


Figure 22. Integrating ATAFS, ModSAF, and the datalogger.

This approach eliminates duplicate controls and input devices and duplication of effort. The EC uses a single keyboard and one mouse to accomplish duties, while the O/C manipulates the 3D view. The AAR workstation proposed in Figure 21 is not just applicable to SIMNET. The CCTT AAR station could employ a similar configuration to exploit ATAFS functionality for 2D and 3D AAR aids.

(3) Features to Support System or Exercise Interruptions. ATAFS saves all AAR aids when the O/C quits the ATAFS application. Users have suggested that ATAFS automatically save all exercise data and AAR aids periodically during the exercise. In the event of a system crash, users could restart ATAFS, recall

the saved exercise, resume observation and control of the battle, and continue to build the AAR presentation started prior to the system crash. Adding this capability would minimize restart time and the loss of data from an exercise in progress.

Users have suggested adding a function to enable the operator to pause data collection and the functioning of ATAFS' expert system. When the network crashes, ModSAF crashes, or the exercise is interrupted temporarily (i.e., to get the platoon back on track), pausing data collection can save storage space. If the pause function also pauses the expert system, ATAFS will not prepare AAR aids that include the time span covered by the exercise interruption. For example, if the exercise is interrupted immediately after a member of the platoon transmits a contact report and the players resume the exercise 30 minutes later, an animated aid covering the platoon's initial actions on contact would be 30 + minutes long with very little player activity portrayed.

(4) Assisting the O/C in the Selection of Critical AAR Aids. ATAFS automatically creates 15-20 aids during a platoon exercise. Typically, the O/C will use only four or five of these aids during the AAR presentation to focus on those causes and effects that significantly impacted on the outcome of the battle. Currently, ATAFS does not assist the O/C in determining which aids of the total set prepared for an exercise are the most critical for the AAR presentation. An AAR, which focuses on those unit actions or inactions that significantly impacted on the overall accomplishment of the tactical mission, provides a strong motivation for player discussions on corrective actions to fix training weaknesses. Linking shortfalls in unit performance to battle outcome appears to promote a more productive post-exercise learning experience than an approach that crosswalks each aspect of unit performance to pertinent tactics, techniques, and procedures publications (Meliza, 1996). SMEs have recommended that ATAFS' expert system be expanded to identify those aids that should be presented during the AAR based on mission outcome. Figure 23 illustrates a modification to the ATAFS' Aid Bin user interface to accommodate this functionality.

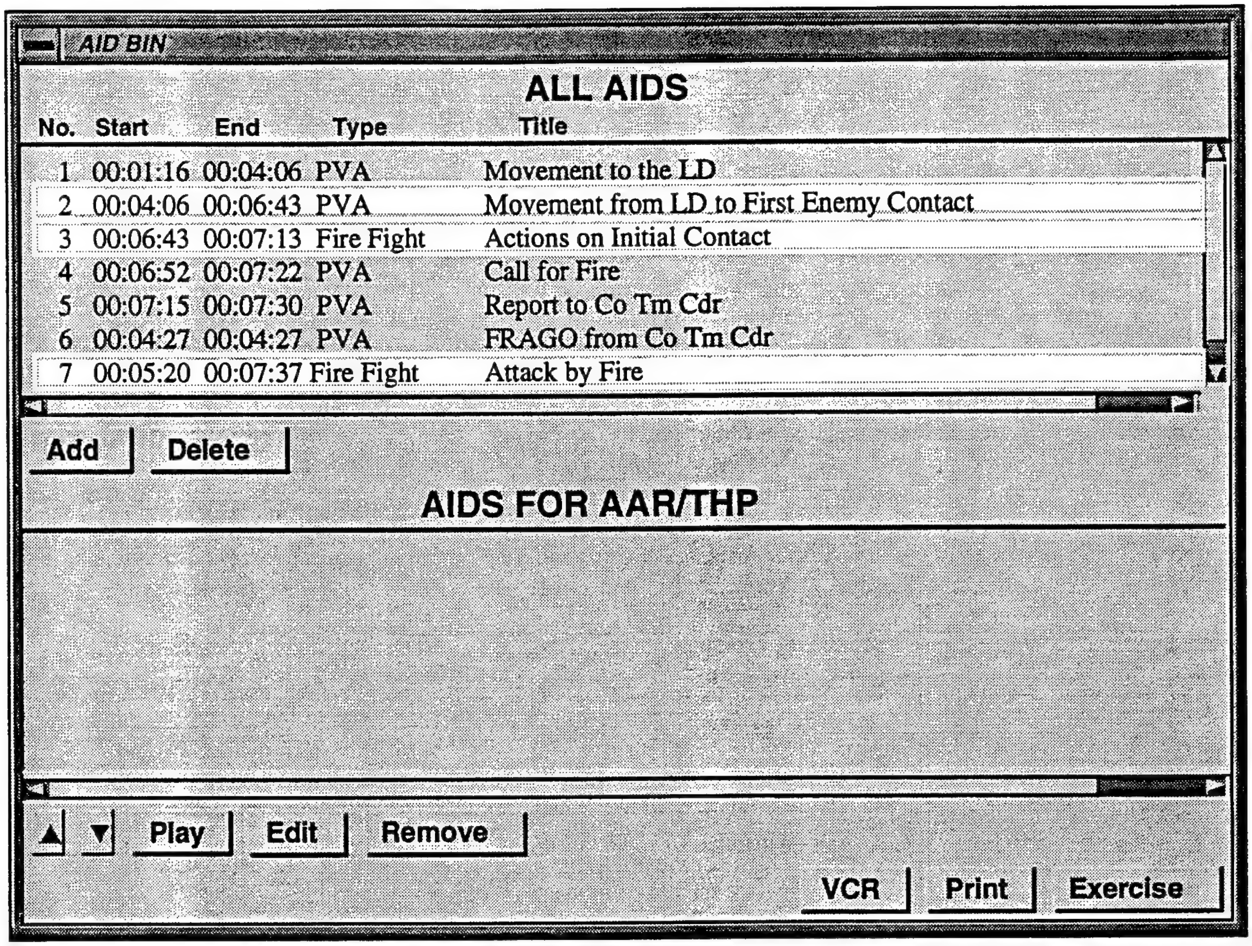


Figure 23. System identifies critical AAR aids based on battle outcome.

(5) CBT. Funding constraints prevented us from concurrently upgrading ATAFS CBT as we implemented software fixes, refinements, and enhancements to the system. SMEs and users indicate that the ATAFS CBT is valuable in training new users and in refreshing the skills of users if they have not operated the system over an extended period of time. Since the CBT is on a CD-ROM that users can operate on a multimedia PC, users can complete initial training or refresher training even if they do not have access to an ATAFS workstation. Users highly recommend that the CBT be revised and distributed with each software upgrade.

(6) How to Improve. ATAFS AAR aids provide the "ground truth" on "What happened" and poses open-ended questions to cause the AAR audience to discuss "Why it happened." However, ATAFS offers no assistance to the O/C to guide discussions on "How to improve." Users have recommended adding a "How to improve" button to ATAFS AAR aids. See Figure 24.

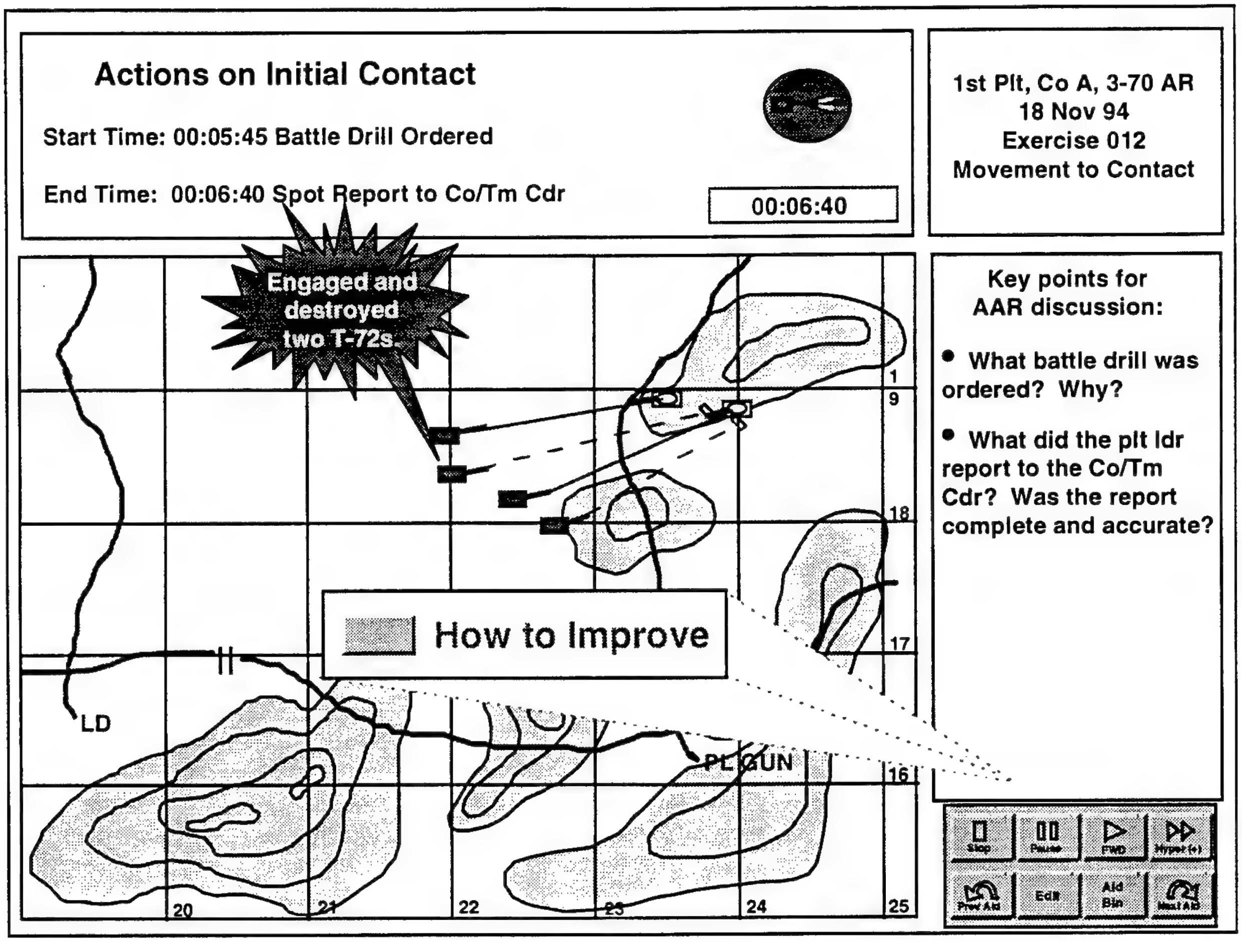


Figure 24. How to improve button.

The "How to Improve" button provides the O/C access to other displays related to the questions posed by the AAR aid. Using the "How to Improve" button, the O/C may present extracts of exercise datalogger tapes showing how other units performed the tactical operation successfully in a similar exercise. The O/C may also use the button to access extracts of tactics, techniques, and procedures publications and instructional slides if the unit requires heavy coaching during the AAR. SMEs have also suggested adding "doctrinal nuggets" and quotes from famous people that the O/C may display to make a key teaching point.

(7) Paper-Based THP. The O/C may prepare a THP video with ATAFS. The video contains all the aids presented during the AAR presentation, as well as other aids the O/C may wish to include in the THP to assist the unit in planning future training. The video is appropriate for a single exercise, but it is not suitable to show how a unit's performance improved over time during a series of exercises, or the unit's state of training at the conclusion of an intense training period. O/Cs prefer a paper-based THP that shows selected AAR aids, provides written

narration of unit performance, and offers summary tables depicting performance assessments by task. O/Cs want an AAR system that allows them to electronically record their evaluations of unit performance and that collects their evaluations over a series of exercises for inclusion in the THP. Evaluation templates tailored to specific exercise tables that are linked to the unit's THP would be particularly useful. The O/C could annotate evaluations on the template using the keyboard and mouse as the exercise progressed or immediately after the exercise. At the end of the training cycle, the O/C could direct the system to build the unit THP. The system would then automatically extract information from each exercise evaluation template and assemble a THP that showed (a) the exercise tables the unit completed, (b) the O/Cs comments and evaluations by task, (c) summary tables that are automatically populated based on the O/C's annotations in the exercise templates, and (d) AAR aids the O/C wishes to include in the package. The THP should also have space for the O/C to provide concluding comments on the unit's state of training at the end of the training period and recommendations for future training.

(8) Flexibility in System-Prepared Data Summaries and Graphs. ATAFS automatically prepares data summary tables and graphs to support the AAR presentation. ATAFS is "hard wired" to collect specific data for specific statistical aids. Users cannot alter the data collected and portrayed on the Y axis and correlate it with data of their choosing on the X axis. They cannot use ATAFS to sort through exercise data to identify trends. Training managers and researchers strongly recommend that the objective AAR system provide the flexibility to support analytical requirements as well as training feedback.

(9) AAR Aid Revisions. During the course of the project we found that O/Cs and SMEs liked the variety of AAR aids produced by ATAFS. However, we did receive recommendations to improve the flexibility of the aids. Users and SMEs have suggested providing an operator control on the Aid Editor that permits the O/C to change the aid from one type of display to another (i.e., from a Plan View Animation to a Battle Flow). This would allow the user to examine unit performance from a different perspective. For example, if the aid was a Plan View Animation showing the unit's activity from crossing the LD to first enemy contact, O/Cs may wish to change the aid to a Battle Flow (showing "snail trails" behind each vehicle) to point out problems in unit movement and navigation. O/Cs have also recommended that we add a manual aid button that permits them to create a blank aid, which they may title and type-in text of their own choosing. O/Cs want the capability to copy and paste text and illustrations from other documents onto the blank aid. This would allow the O/C to

develop any number of unique aids such as "Areas Requiring Improvement."

(10) Revisions in Exercise Timeline. The timeline used by the ATAFS was based upon the Unit Performance Assessment System (UPAS) timeline. A key difference between these timelines is that the identification of periods when an entire platoon is halted requires a situation where there is absolutely no change in the location of any platoon vehicles with ATAFS while the UPAS allows vehicles to move up to 10 meters within a one minute period (Meliza et al., 1994). The UPAS system employs a less restrictive criterion, because it was discovered that individual vehicles often move a few meters in halt positions to, for example, improve the fields of observations of crews. This less restrictive criteria needs to be implemented in the ATAFS, because cases have been observed where platoons were clearly halted but never meet the strict non-movement criterion.

Another feature of the UPAS Timeline not carried over to the ATAFS is the capability to display information about when various types of radio communications occurred (Meliza and Tan, 1996).

Developing ATAFS Authoring Tool

The final task in the project was to develop an ATAFS Authoring Tool (ATAFS-AT) so that non-programmers could reuse/modify existing ATAFS rule sets or develop new rule sets for automated AAR aids. Funding constraints precluded development of an ATAFS-AT prototype. However, we did develop the concept of operation, functional requirements, a partial object-oriented analysis, and a screen-deep user interface for ATAFS-AT. We defined system functional requirements and the user interface through the development of the ATAFS-AT software user's manual (LB&M, 1996c). Iterative reviews of draft manuals, combined with in-progress review presentations and demonstrations of the user interface, gave us the feedback required to develop an intuitive GUI and to define the functional requirements for the system. SME and programmer development of automated AAR aids for tank platoon missions using CLIPS, greatly assisted us in defining precisely what a non-programmer must do and what the machine must do to produce AAR products with an ATAFS-AT application.

We developed expert system rule sets for three tank platoon missions: (a) Conduct movement to contact, (b) Execute a platoon defensive mission, and (c) Conduct a tactical road march. ATAFS automatically prepares AAR aids for units that conduct these missions during SIMNET exercises. However, what if the training organization wanted to design an exercise table that offered both defensive and offensive scenarios? Let's say the training organization wishes to design an exercise table in which a platoon moves from a tactical assembly area to a battle position, conducts a defense, then passes through another unit in a counterattack as part of a company team offensive operation. The rule sets necessary to generate AAR aids for the new exercise table are scattered among the three platoon missions embedded in ATAFS' expert system and are not configured to meet the AAR requirements for the table. What is needed is a capability for the training analyst to develop new rule sets and to cut and paste among existing rule sets to tailor ATAFS AAR products for new exercise tables or collective tasks. If the government chooses to continue the development of ATAFS-AT, the training analyst will be able to use ATAFS-AT to develop automated AAR aids without the assistance of a computer programmer.

Training analysts must have a general understanding of how ATAFS' expert system creates AAR aids before they can effectively use ATAFS-AT to create new rule sets to automate AAR aid production. We will discuss the functioning of ATAFS' expert system first then show how the analyst interfaces with ATAFS-AT to create automated AAR products.

How ATAFS Creates AAR Aids

How does ATAFS know what to title an AAR aid, when to start and end preparation of an aid, and what to title the tactical events associated with beginning and ending times? How does ATAFS know what the key discussion points are for the aid, what type of AAR aid to prepare, and what to portray in the map window? The answers to these questions are embedded in ATAFS' expert system, which contains all the information needed to prepare each AAR aid.

ATAFS prepares AAR aids without assistance from the O/C for those tactical events the system is able to recognize. For example, ATAFS can detect direct and indirect fires, vehicle kills, and vehicles crossing control measures (i.e., the LD). Events recognized by ATAFS that trigger the start or end of an AAR aid are "computer-actuated triggers." AAR aids generated totally by computer-actuated triggers require no assistance from the O/C to prepare the aid. See Figure 25 for an example of an aid initiated and concluded by computer-actuated triggers.

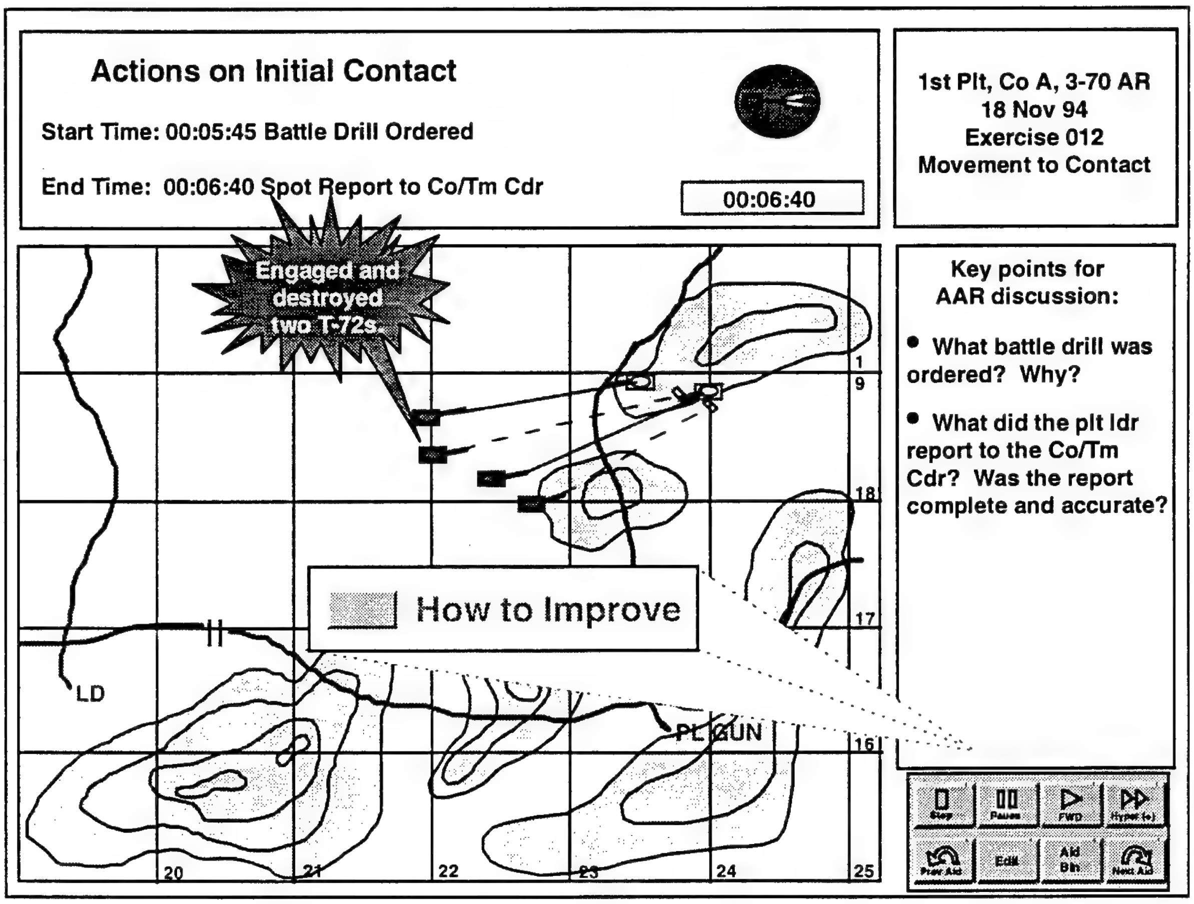


Figure 25. AAR aid generated by computer-actuated triggers.

In the above example, the expert system initiated preparation of the aid when the system sensed vehicles crossing the LD (starting event trigger) and concluded the aid when the system sensed the firing of the first BLUFOR direct fire round (ending event trigger). The starting event and ending event triggers were both computer-actuated triggers. The ATAFS' expert system prepared the aid without any assistance from the O/C.

ATAFS concluded the aid in the previous example based on the first BLUFOR direct fire. However, there other possible conditions that could have initiated contact with the enemy. For example, a member of the BLUFOR platoon could have acquired the enemy visually and transmitted a contact report to alert the platoon of the nature and location of the threat. Since ATAFS has no voice recognition capability, the system relies on the O/C to detect critical tactical voice communications and to notify the system of these transmissions.

In the aid in Figure 26 below, the system detected the platoon's crossing of the LD and initiated preparation of the aid. To conclude the aid, ATAFS relied on the O/C to detect the contact report transmitted on the platoon net. In other words, ATAFS initiated preparation of the aid with a computer-actuated trigger (crossing the LD) and concluded the aid with a human-actuated trigger (the O/C's detection of the contact report).

The Exercise Monitor (Figure 27) provides the O/C the capability to monitor the exercise in near-real time or in exercise history, to create custom/manual AAR aids in addition to those aids automatically produced by the system, and to notify ATAFS of those tactical events that the system relies on him to detect. The Prompts window on the right side of the Exercise Monitor contains the events that the O/C is responsible for detecting (i.e., human-actuated triggers). In Figure 27, the O/C has heard a member of the tank platoon transmit a contact report on the platoon command net and informed ATAFS of the event by depressing the button adjacent to the Contact Report prompt and then clicking the OK button.

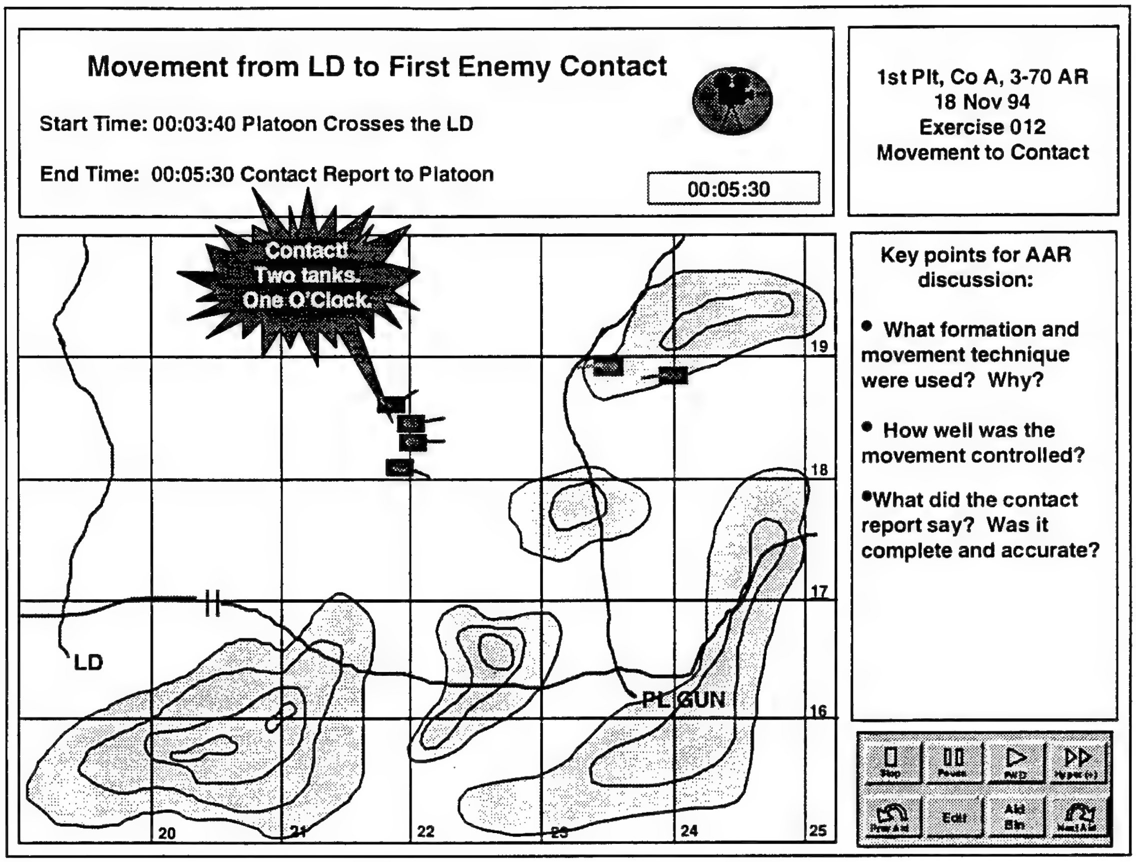


Figure 26. Aid generated by computer and human-actuated triggers.

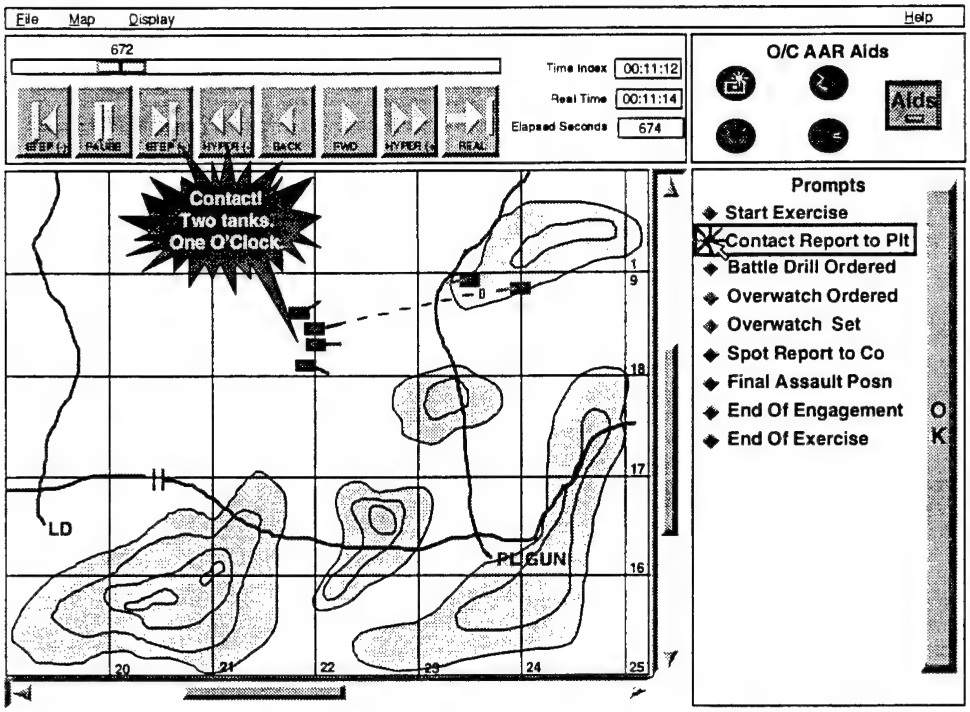


Figure 27. Prompts

For each AAR aid, the expert system has a rule set that serves as a blue print to construct the aid. We derived ATAFS rule sets through a detailed analysis of tank platoon collective tasks, sub-tasks and standards. We designed each aid to portray the platoon's activities during critical phases of the operation and to generate discussion among the AAR audience about their performance. Our analysis identified the tactical events and triggering mechanisms that would start and conclude each aid. The result was the generation of AAR aids portraying various exercise time spans linked to the critical phases of the tactical mission. In our analysis of each potential AAR aid, we addressed each of the five rule set elements below.

(1) <u>The Aid Type</u>. First we determined what aspect of the player unit's activity we wished portrayed, then we selected the aid type (Figure 28) that would best depict that activity.

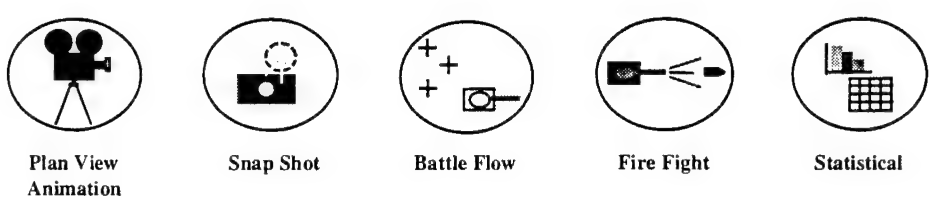


Figure 28. Aid types.

(2) A Descriptive Title for the Aid. Based on the unit activity we planned to depict in the map or statistical area of the aid, we developed a descriptive title for the aid (Figure 29).

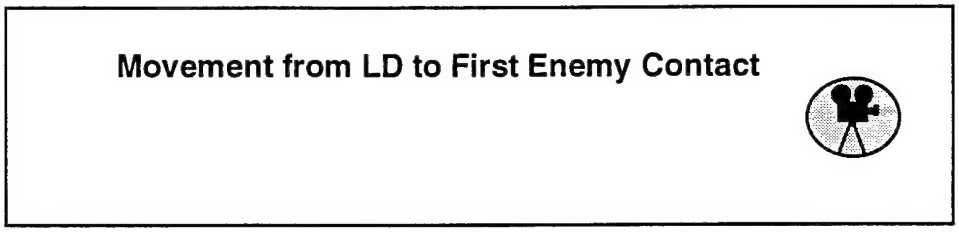


Figure 29. Aid title.

(3) Beginning and Ending Tactical Events. Based on the unit activities we wished to portray on the aid, we identified the precise tactical event that would initiate the aid and the specific event that would conclude the aid. See Figure 30. (NOTE: When ATAFS prepares the aid, the system automatically annotates the start and end times for the aid based on when the computer or human-actuated triggers are fired.)

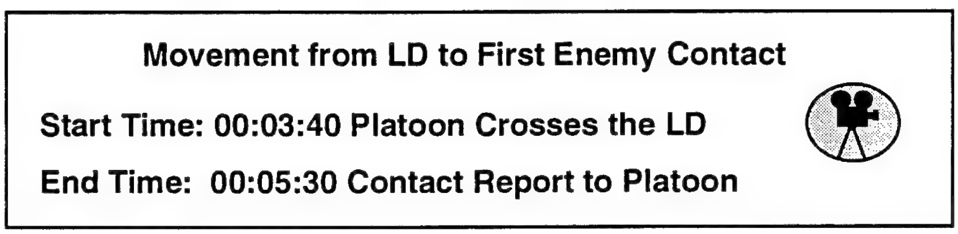


Figure 30. Initiating and concluding tactical events.

(4) Computer-Actuated and Human-Actuated Triggers. Next we identified the triggers associated with the starting and ending tactical events that would initiate/conclude the aid's production. ATAFS currently uses four computer-actuated triggers and one human-actuated trigger to initiate or conclude preparation of an aid (Figure 31). The Line Trigger senses when a vehicle(s) crosses a linear control measure such as the LD. The Area Trigger senses when a vehicle(s) enters an enclosed area such as an objective or battle position. The Kill Trigger generates AAR aids based on a percentage of unit vehicles killed. The Firing Trigger senses firing events such as the first round fired in an engagement. The Prompt Trigger is the only human-actuated trigger. The O/C or trainer activates this trigger by responding to one of the interactive prompts on the right side of the Exercise Monitor (Figure 27 above).

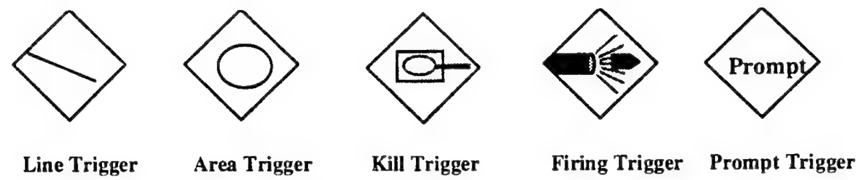


Figure 31. Triggers.

(5) Key Points for AAR Discussion. Finally we developed open-ended questions to generate discussion among members of the AAR audience on the unit's performance as depicted on the aid (Figure 32). These questions/key teaching points were tailored to the aid type and the specific tactical events that initiated and concluded the aid.

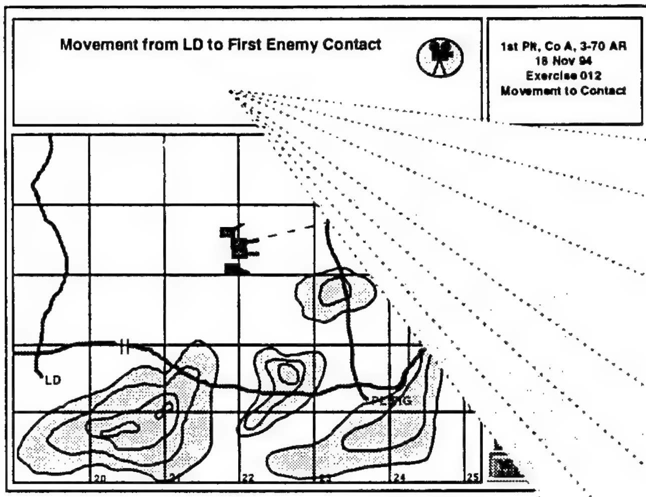
Key points for AAR discussion:

- **What formation and movement technique were used? Why?**
- **How well was the movement controlled?**
- **What did the contact report say? Was it complete and accurate?**

Figure 32. Questions to generate discussion among the AAR audience.

Now let's discuss each element of a rule set and see how the elements function together to build an AAR aid. In Figure 33 below, the rule set calls for ATAFS to produce a Plan View Animation entitled: "Movement from LD to First Enemy Contact." A single condition/tactical event initiates preparation of the aid (crossing the LD). However, since the concluding tactical event (first enemy contact) can be caused by any one of three conditions (contact report, BLUFOR fires first, OPFOR fires first), the rule set may build any one of three AAR aids depending on the actual tactical event that occurs during the exercise. As illustrated in Figure 33, the rule set will trigger the labeling of the appropriate tactical event for the End Time based on what actually happens during the exercise. If the O/C monitors a contact report and clicks the Contact Report to Plt prompt, ATAFS will label the ending event "Contact Report to

Platoon." However, if there is no contact report or the report is rendered after the system senses the first BLUFOR or OPFOR firing, ATAFS will label the ending event with either the label for ending event (2) or ending event (3) as appropriate. Note: The O/C will still have the ability to play back a late contact report in a subsequent AAR aid prepared by the system.)



ATAFS constructs an AAR aid showing unit actions from crossing the LD to first enemy contact. Any of the following conditions could result in the first enemy contact:

(1) A member of the platoon transmits a contact report.

Start Time: 00:03:40 Platoon Crosses the LD
End Time: 00:05:30 Contact Report to Platoon

(2) BLUFOR fires the first direct-fire round.

Start Time: 00:03:40 Platoon Crosses the LD
End Time: 00:05:30 BLUFOR Fires First

(3) OPFOR fires the first direct-fire round.

Start Time: 00:03:40 Platoon Crosses the LD
End Time: 00:05:30 OPFOR Fires First

Figure 33. AAR aid with three possible ending events.

The key teaching points listed within the Key Points for AAR Discussion window are dependent on which one of the three ending conditions actually concludes the aid during the exercise. See Figure 34. The rule set contains variations of key teaching points which are matched to each of the three ending conditions. As you can see in Figure 33 the last question in each set of key teaching points is different depending on which tactical event actually occurs during the exercise. ATAFS rule sets take into consideration the potential variations of player activity that may occur during the exercise and prepare AAR aids that reflect the unit's actual response.

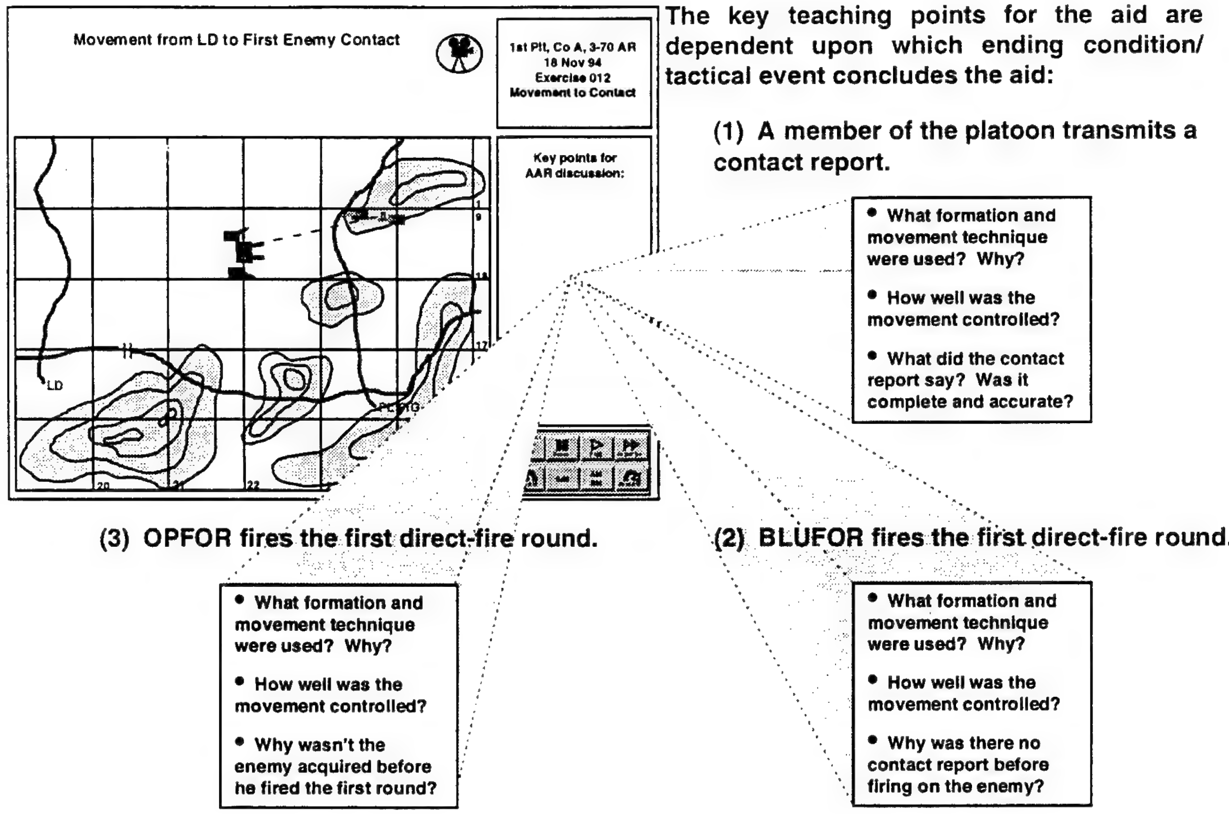


Figure 34. Key teaching points are dependent on the ending event.

How Non-Programmers Would Employ ATAFS-AT

Using ATAFS-AT to develop automated AAR products for an exercise table requires a front-end analysis of the tasks the unit will perform during the exercise followed by the input of analysis results into the ATAFS-AT application. We recommend that the training analyst use a four step process to develop rule sets to generate AAR aids.

(1) Develop an Exercise Scenario Overlay to provide an overview of the possible tactical events that may occur during the exercise.

(2) Develop Series Diagrams and AAR Aid Descriptions to determine the type of AAR aids needed and their content.

(3) Construct an ATAFS-AT Flow Diagram to outline how each rule will function.

(4) Establish parameters for each icon in the flow diagram to define the specific processes the rule will use to generate the AAR aid.

In the paragraphs that follow we discuss each step of the process.

In the first step, we recommend that the training analyst develop an exercise scenario overlay with a chronological activity listing. See Figure 35. Wherever possible, analysts should break down the exercise scenario into phases so they can focus their attention on each segment of the scenario. Next, analysts should prepare a list of chronological activities that the unit may or may not accomplish during the execution of each phase of the scenario. When completed, the exercise scenario overlay provides analysts with an overview of the tactical events that could occur during the course of the exercise. Training analysts will use the scenario overlay as a reference to determine the AAR aids they wish ATAFS to prepare for the exercise table.

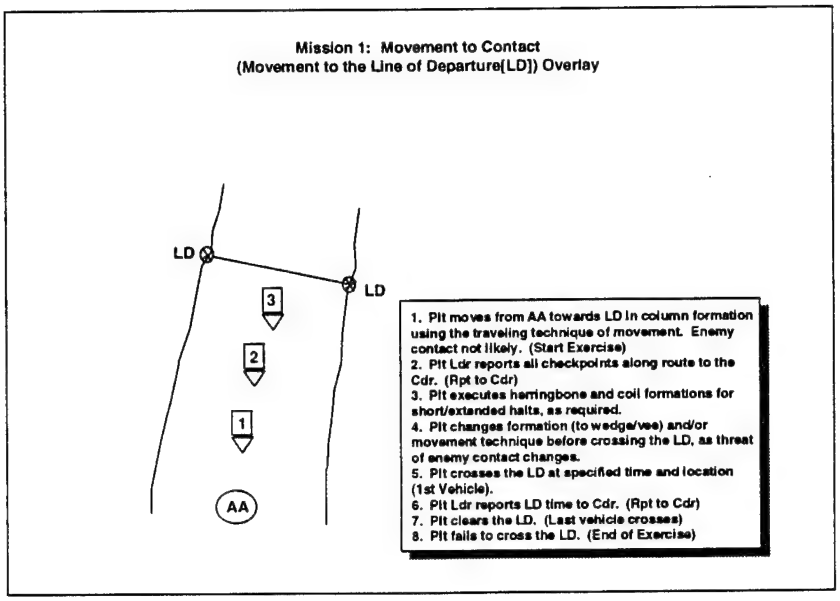


Figure 35. Sample exercise scenario overlay

In the second step, the analysts will determine the type aid, triggering mechanisms, and aid content for each aid they want ATAFS to prepare for the exercise table. We recommend that analysts prepare series diagrams to outline each AAR aid they want ATAFS to build by scenario phase. In Figure 36 analysts prepared Aid Series 1 to outline the aids they want ATAFS to prepare showing the unit's crossing of the LD. They have determined that the best type of aid to show the unit's activity is a PVA and have numbered and titled the aid. They have identified the tactical events that will initiate and conclude the aid and the corresponding triggering mechanisms. In the second aid (Aid 1.2), the users have outlined an aid that will

depict the unit's activities in the event the unit becomes disoriented and fails to cross the LD. In this case they have decided to use a Battle Flow which will provide a trace (snail trail) of each vehicle's movement over time. They plan to initiate the Battle Flow at the start of the exercise and to terminate the aid when the O/C recognizes that the unit can gain no further training value from the exercise (i.e. the unit cannot locate the LD after extensive land navigation and the O/C decides to end the exercise).

Aid Series: 1

Exercise Phase: Start of Exercise to Crossing of the LD

Aid Number, Title and Type	Possible Starting Events and Triggers	Possible Ending Events and Triggers
Aid 1.1 Platoon's Movement to LD (PVA)	EVENT: Platoon moves toward LD. TRIGGER: O/C actuates *Start Exercise* prompt.	EVENT: 1st vehicle crosses LD. TRIGGER: Line Trigger used so ATAFS can sense the unit's crossing of the LD.
Aid 1.2 Platoon Fails to Cross LD (BF)	EVENT: Platoon moves toward LD. TRIGGER: O/C actuates *Start Exercise* prompt.	EVENT: Platoon does not cross the LD. TRIGGER: Two conditions must exist for ATAFS to prepare this aid. First, ATAFS must sense that the unit did not cross the LD. Second, the O/C must actuate the End of Exercise prompt.

Figure 36. Sample Series Diagram

In Figure 37 the analyst has developed a series diagram for an aid which is initiated by a single starting event/trigger and concluded by one of three ending events/triggers. The ending event/trigger that occurs first will cause ATAFS to produce the aid.

Aid Series: 2		
Exercise Phase: Movement from LD to First Enemy Contact		
Aid Number, Title and Type	**Possible Starting Events and Triggers**	**Possible Ending Events and Triggers**
2.1 Platoon Crosses LD (PVA)	EVENT: 1st vehicle crosses LD. TRIGGER: Line Trigger used so ATAFS can sense the unit's crossing of the LD.	EVENT: Contact report sent. TRIGGER: O/C actuates *Contact Report* prompt.. EVENT: BLUFOR fires first direct fire round. TRIGGER: ATAFS senses first BLUFOR round fired using the Firing Trigger. EVENT: OPFOR fires first direct fire round. TRIGGER: ATAFS senses first OPFOR round fired using the Firing Trigger.

Figure 37. Series diagram for an aid with multiple starts and ends.

The series diagrams serve as an outline for the aids the analyst wants ATAFS to create for an exercise table. The next step is to complete an AAR Aid Description for each aid. See Figure 38.

The AAR Aid Description contains all the instructions analysts will enter into ATAFS-AT to construct each aid. Much of the information for the aid is contained in the series diagram. Analysts add the open-ended questions they want the aid to pose to the AAR audience at the bottom of the AAR Description to complete the information needed by ATAFS to build the aid. The shaded areas of the AAR Aid Description are optional and are for the analyst and training organization's use. Stating the purpose of the aid helps others understand why analysts developed the aid and assists analysts in developing open-ended questions for the aid that will generate discussion focused on task standards. Analysts may want to cross reference other useful information, such as the ARTEP tasks and other exercise tables supported by the aid.

AAR AID DESCRIPTION		
EXERCISE TABLE: 17-237-10.4 Movement to Contact		
AID NO. 1.1	**TITLE:** Platoon's Movement to and Across the LD	**TYPE AID:** PVA
PURPOSE: To assist the O/C and AAR audience in the evaluation and discussion of: 1. Formations and movement techniques employed by the platoon. 2. Position and interval of each vehicle within the formation and movement techniques. 3. Use of graphic control measures in controlling the platoon's movement. 4. Platoon leader's control of the platoon's movement. 5. Actions of each BLUFOR vehicle when changing formation and/or movement technique. 6. Platoon leader's decision to change formations/movement technique. 7. Accuracy and completeness of the reports sent to and by the platoon.		
RELATED ARTEP TASKS: Execute a staggered column formation (17-3-0204) Execute a wedge formation (17-3-0205) Execute a vee formation (17-3-0206) Execute an echelon formation (17-3-0208) Execute traveling (17-3-0209) Change of formation drill (Battle Drill 1)	**RELATED EXERCISE TABLES:** 17-237-10.1 Formations 17-237-10.5 Hasty Attack 17-237-10.6 Actions on Contact	
START EVENT: Platoon begins movement toward LD.	**END EVENT:** Last BLUFOR vehicle crosses the LD.	
START TRIGGER: O/C actuates Start Exercise prompt	**END TRIGGER:** ATAFS senses last vehicle cross the LD using the Line Trigger	
QUESTIONS: 1. What formation and movement techniques were used? Why? 2. What was the threat situation? 3. How did the graphic control measures aid in navigation?		

Figure 38. AAR aid description.

For an aid with multiple starting and/or ending events, the analyst completes extensions to the Aid Description. See Figure 39.

START EVENT: Platoon begins movement toward LD.	**END EVENT:** Platoon leader reports crossing the LD
START TRIGGER: O/C actuates Start Exercise prompt	**END TRIGGER:** O/C actuates Rpt to Commander Prompt
QUESTIONS: 1. What formation and movement techniques were used? Why? 2. How well did the platoon navigate to the LD? 3. Why should a platoon leader report crossing control measures?	

Figure 39. AAR aid description extension.

The third step in building rule sets to automate AAR aid production is to construct a flow diagram using ATAFS-AT icons. The analyst will choose icons from a "tool box", place the icons in a rule construction area, then arrange and connect the icons to create a flow diagram similar to the one in Figure 40.

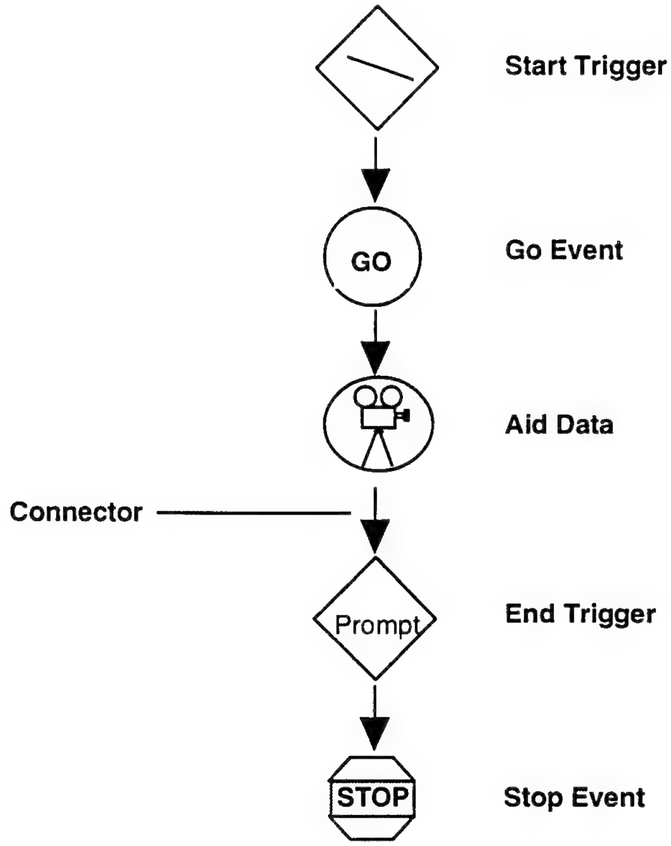


Figure 40. Flow diagram for an AAR aid.

A Start or End Trigger icon contains a mechanism that causes ATAFS to initiate or terminate an AAR aid. The Go Event icon contains the description of the tactical event that is associated with the Start Trigger icon that will initiate the AAR aid. The Stop Event icon contains the label of the tactical event that corresponds to the End Trigger that will conclude the aid. The Aid Data icon provides ATAFS information on the type of aid the analyst wants built. The analyst will use the Connector icon to link icons together.

All AAR aid types except the Snap Shot consist of at least one Start Trigger with a corresponding Go Event, an Aid Data icon, and at least one End Trigger with a corresponding Stop Event. The Snap Shot will have at least one Start Trigger, a GO Event, and an Aid Data icon but will not have an End Trigger or Stop Event since the aid portrays player activity at an instance in time.

Figure 41 is an example of a single AAR aid with multiple possible triggers. The analyst wishes to build an AAR aid displaying the unit's actions on enemy contact based on the possible conditions that could initiate and conclude the engagement. One of three conditions could initiate contact with

the enemy. A member of the player platoon could transmit a contact report notifying the platoon of the threat. The contact could be initiated by BLUFOR firing the first direct fire round or OPFOR firing the first direct fire round. The user sees three conditions that could conclude the direct fire engagement. All OPFOR are killed during the engagement. All BLUFOR are killed or BLUFOR bypasses OPFOR and passes beyond direct fire range of OPFOR.

Training analyst wishes to build an AAR Aid displaying the unit's actions on enemy contact based on the possible conditions that could initiate and conclude the engagement.

User wants to initiate the aid with:

- **The Contact Report or**
- **1st BLUFOR Direct Fire or**
- **1st OPFOR Direct Fire**

whichever occurs first.

User wants to conclude the aid when:

- **All OPFOR Killed or**
- **All BLUFOR Killed or**
- **BLUFOR bypasses OPFOR and neither can range the other.**

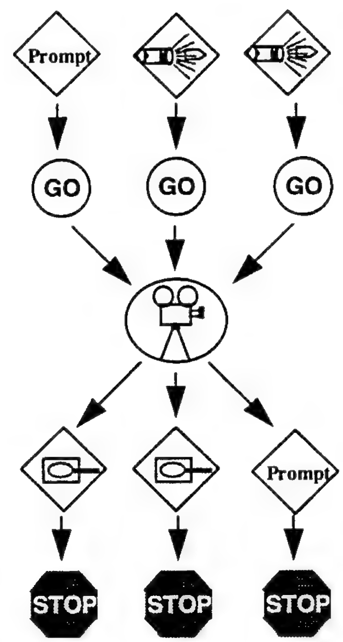


Figure 41. Single AAR aid with multiple possible triggers

Figure 42 depicts the correlation between the components of the AAR aid and ATAFS-AT icons. The Aid Data icon tells ATAFS what type of AAR aid to build. In this case the icon instructs ATAFS to produce a Plan View Animation. The GO Event informs ATAFS how to label the tactical event (Platoon Crosses the LD) that will initiate the aid. The Start Trigger icon contains information on the mechanism that will cause ATAFS to start production of the aid. In this case, a Line Trigger will cause ATAFS to initiate production of the aid when the system senses that the platoon's vehicles have crossed the LD. The Stop Event provides ATAFS the label of the tactical event (First BLUFOR Fire) that will conclude the aid. The End Trigger provides ATAFS the mechanism that will conclude the aid. In this example a Firing Trigger will cause ATAFS to conclude the aid when the system senses the first round fired by BLUFOR.

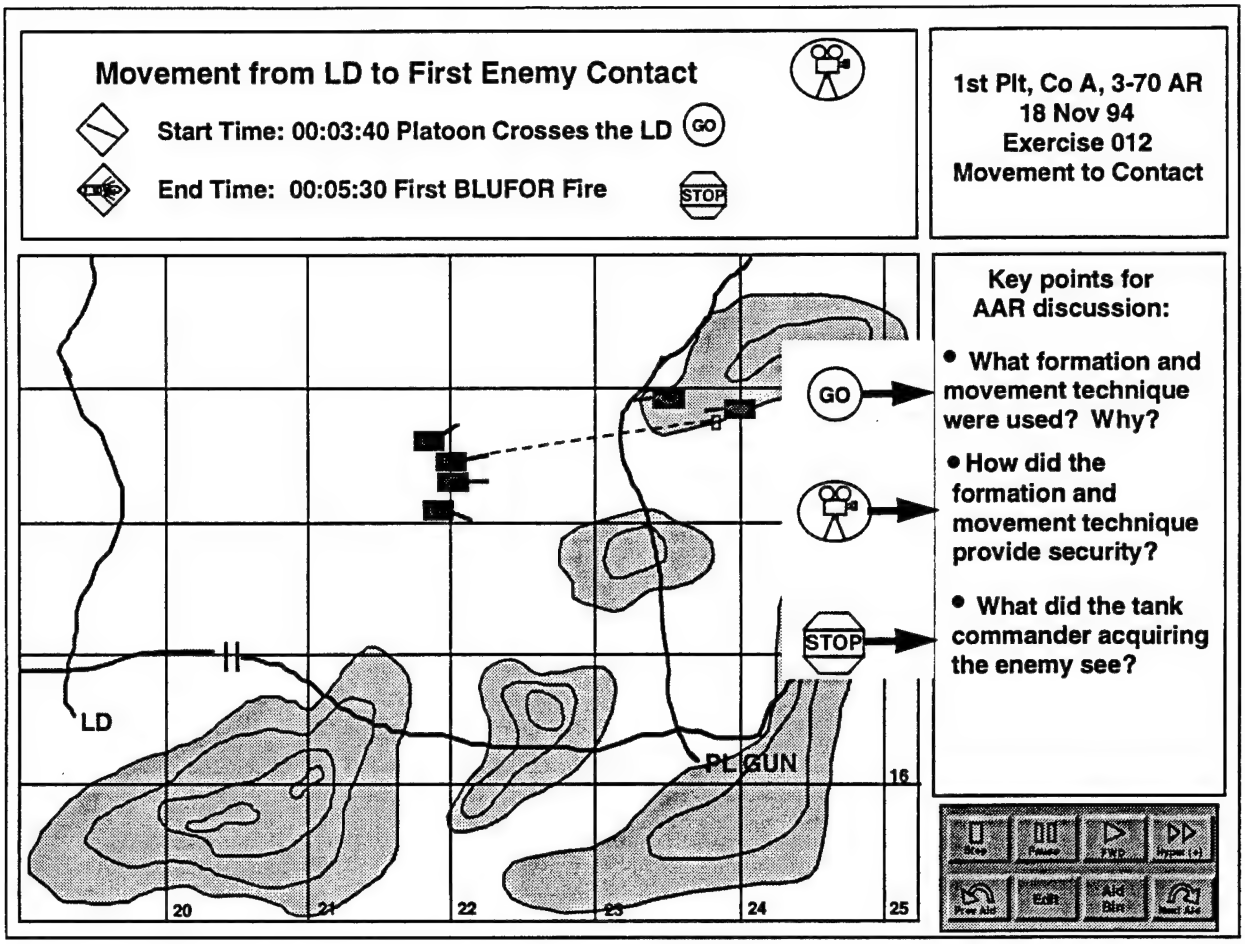


Figure 42. Correlation between an AAR aid and ATAFS-AT icons.

The Go Event, Stop Event, and Aid Data icons also contain questions that ATAFS will post under the Key Points of Discussion section of the AAR aid. Those questions that are pertinent to the aid's initiating tactical event are contained in the Go Event icon. Those questions that are applicable to the concluding tactical event for the aid are listed in the Stop Event icon. Those questions that are pertinent regardless of the tactical event that initiates or concludes the aid are contained in the Aid Data icon.

The last step in developing automated AAR aids with ATAFS-AT is to define parameters for each icon in the flow diagram for your aid. ATAFS-AT provides the analyst dialogue boxes similar to the one in Figure 43 to define the parameters for each icon.

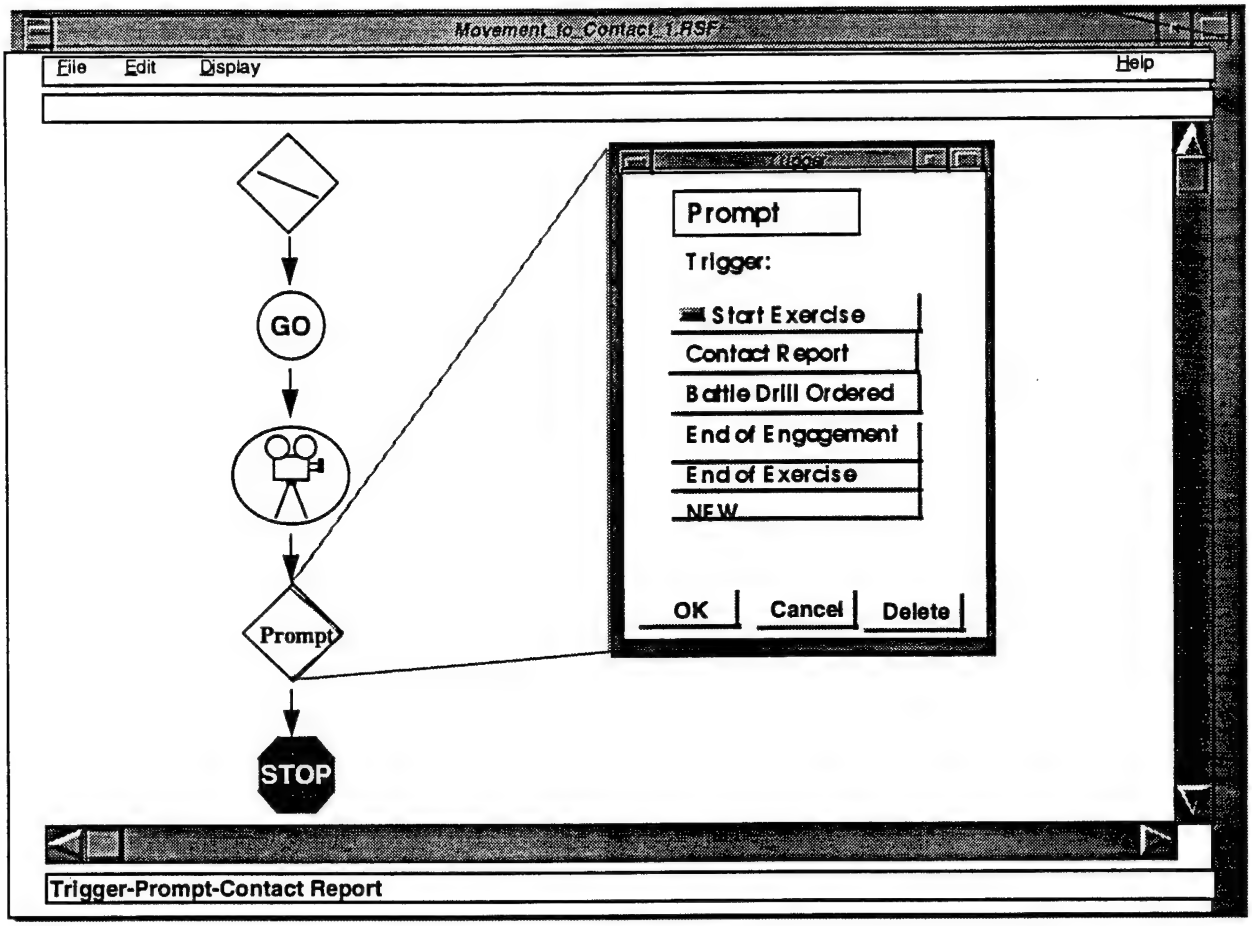


Figure 43. Defining icon parameters.

Conclusions

During this 16 month effort, our principal objectives were (a) to test and refine ATAFS and a user POI in a variety of training environments during training conducted by ARNG tank platoons , and (b) to provide an ATAFS for testing and experimentation to support the development of an AAR workstation for the Army's next generation of networked simulators, the CCTT. We accomplished these objectives and provided the government ATAFS source code, executable code, and documentation with unlimited rights to apply ATAFS technology to any military application.

ATAFS demonstrated technology that the government can leverage to automate AARs for constructive and live simulations as well as existing and emerging virtual simulations. Developers of the STAARS view ATAFS as a technology that has great potential to meet many of the STAARS requirements. There is also strong interest in integrating ATAFS capabilities into the CCTT AAR system to automate AAR preparations.

We developed a prototype AAR system that supports the inexperienced as well as the seasoned O/C. O/Cs with widely varying AAR experience were able to master operation of ATAFS with very little training. Most O/Cs achieved proficiency in the operation of ATAFS after 2 hours of computer-based training and a 1.5 hour practical exercise. We observed instances in which O/Cs successfully prepared AARs with ATAFS after only a 30 minute demonstration of the system.

ATAFS has served as a dynamic test bed that has evoked suggestions and recommendations from current and potential users. During demonstrations and O/C and SME use of ATAFS, we received numerous recommendations to improve the system. We implemented many user recommendations, but there are many enhancements required to achieve the total functionality desired by O/Cs, researchers, and analysts. We sense the biggest concern among SMEs and users is the competition between exercise control and AAR preparation for the O/C's attention. AAR preparations must not distract the O/C from control functions while an exercise is in progress. The O/C's orchestration of control activities to insure the player unit has the opportunity to achieve its training objectives for the exercise is paramount to AAR preparation. We have proposed a solution to the exercise control/AAR preparation dilemma that we are prepared to develop and test in SIMNET or the CCTT DIS environment.

During briefings and demonstrations of the ATAFS-AT graphical user interface, we found that training managers, analysts, and researchers are keenly interested in the continued

development of the authoring tool. All recognize the potential of this tool to support the development of automated, standardized AAR products and to devise rule sets to extract data for research purposes without contractor or programmer involvement. We developed a rough order of magnitude cost estimate to complete ATAFS-AT and provided our estimate to the COR. Functionality for the tool is fully defined in a software user's manual, which will serve as our starting point if the government decides to reinitiate the project.

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LIST OF ABBREVIATIONS AND ACRONYMS

AAR	After Action Review
ARI	US Army Research Institute
ARNG	US Army National Guard
ARSI	Defense Advanced Research Projects Agency Reconfigurable Simulation Initiative
ATAFS	Automated Training Analysis and Feedback System
ATAFS-AT	Automated Training Analysis and Feedback System-Authoring Tool
BLUFOR	Blue Force (Friendly Force)
CATT	Combined Arms Tactical Trainer
CBT	Computer-Based Training
CCTT	Close Combat Tactical Trainer
CD-ROM	Compact Disk-Read Only Memory
CLIPS	C Language Integrated Production System
COR	Contracting Officer's Representative
COTS	Commercial-Off-The-Shelf
DARPA	Defense Advanced Research Projects Agency
DIS	Distributed Interactive Simulation
EC	Exercise Controller
GUI	Graphical User Interface
LB&M	LB&M Associates, Inc.
LD	Line of Departure
ModSAF	Modular Semi-Automated Forces
MTP	Mission Training Plan
MWSTC	Mounted Warfare Simulation Training Center
O/C	Observer/Controller

OPFOR	Opposing Forces
PC	Personal Computer
POI	Program of Instruction
PVA	Plan View Animation
RCVTP	Reserve Component Virtual Training Program
SBIR	Small Business Innovation Research
SGI	Silicon Graphics, Inc.
SIMITAR	Simulation in Training for Advanced Readiness
SIMNET	Simulation Networking
SIMUTA	Simulation-Based Multi-echelon Training Program for Armor Units
SME	Subject Matter Expert
STRICOM	US Army Simulation, Training and Instrumentation Command
STAARS	Standard Army After Action Review System
THP	Take Home Package
TI	Texas Instruments
2D	Two Dimensional
3D	Three Dimensional